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Assessment of the Environmental Implications of Project Independence

Energy Resources Co, Inc, Cambridge, Mass

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Jul 76

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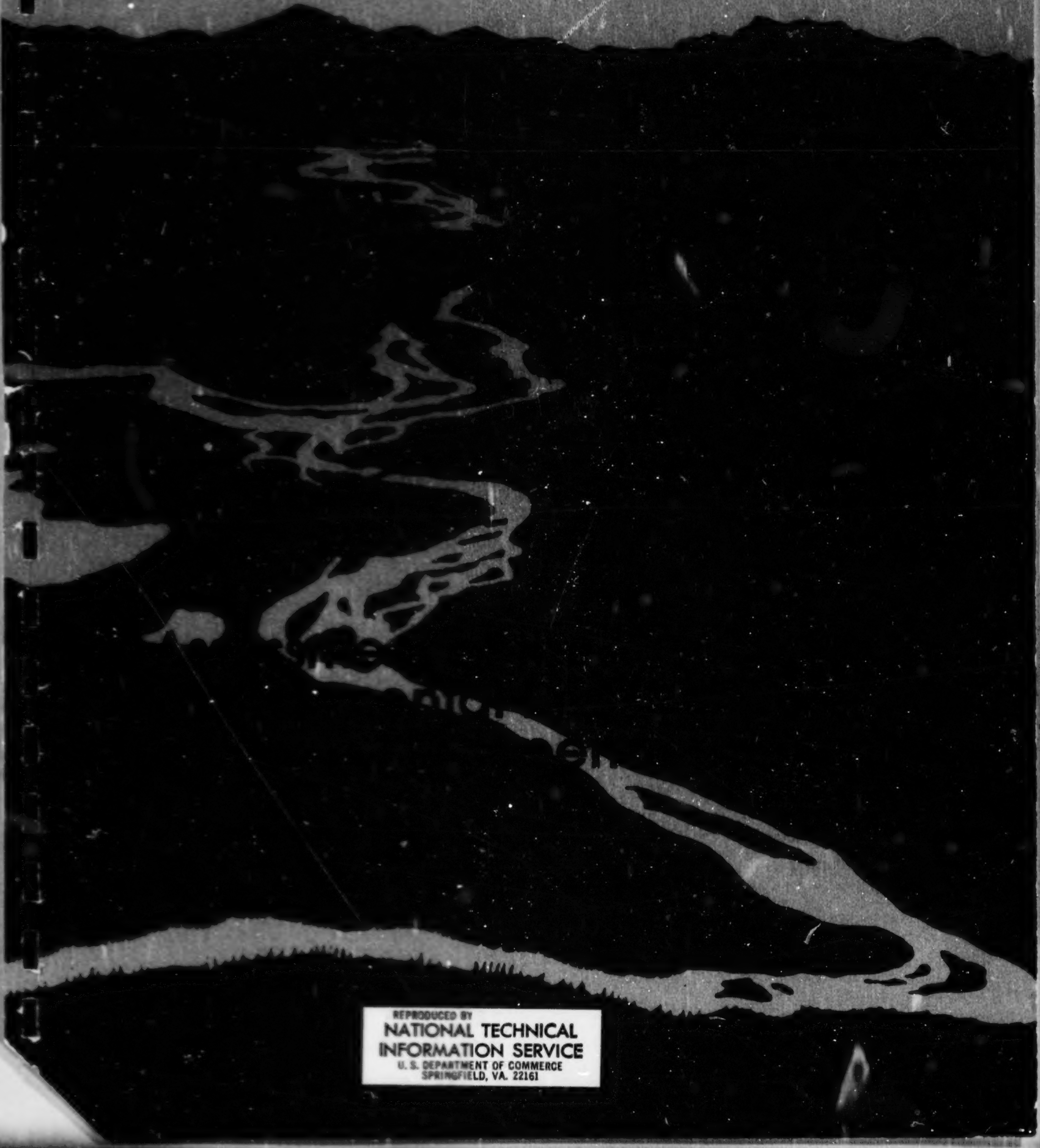

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Uranium,
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An environmental residuals technique was developed to quantitatively evaluate the environmental implications of Project Independence. Three models are discussed that compare the regional impacts of different scenarios of energy development: a Residual Allocation Model to predict the quantity and distribution of 15 energy-associated pollutant loadings, a Water Use Model to assess the compatibility of water available and water required for projected energy use, and an Air Quality Model to compare the impacts of the scenarios on ambient air quality. The approach is useful for scenario comparison, but is limited in degree of detail and absolute accuracy. It is concluded that the level of control technology achieved is more critical environmentally than the choice of scenarios. Further work should include a refinement and extension of the residuals studied and a more detailed sensitivity analysis, especially with respect to control technology and facility siting assumptions.

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FOR
OFFICE OF PLANNING AND EVALUATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Project Officer: R. Livingston

JULY 1976

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The authors wish to express their appreciation to Mr. Richard Livingston, EPA Project Officer, for his guidance, support and comments throughout the study and during the preparation of this report.

Foreward

This report is divided into two parts. The first part contains a discussion of an environmental assessment model that was developed to analyze environmental impacts for a variety of scenarios of energy development. The second part of the report discusses the analysis of the scenarios provided by the Federal Energy Administration. This is presented primarily for historical purposes. The final chapter of this report lists conclusions derived from the analyses of all the scenarios.

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PART I

DEVELOPMENT OF AN ENVIRONMENTAL ASSESSMENT MODEL

INTRODUCTION TO PART I

This project arose as one component of the Project Independence interagency effort to analyze the environmental implications of alternatives for a national energy policy. The Project Independence effort first assembled a comprehensive energy data base and then developed the Project Independence Evaluation System (PIES) to analyze future energy supply and demand alternatives and investigate the impacts and implications of major energy strategies. Input to PIES is a set of supply-demand alternatives. Output is a scenario of the types, levels and distribution of energy activities and their associated environmental residuals.[1] The Environmental Protection Agency (EPA) was given the responsibility of assessing the environmental impacts of the energy scenarios generated by PIES. The assessment had to be performed quickly, repetitively and in a consistent fashion using quantitative, objective techniques wherever possible. This led to the formulation for EPA of three computer models to evaluate the regional environmental impacts associated with the residuals projected by PIES for each scenario.

The purpose of this report is to present these models and the results of the scenario analyses performed thus far. The results of the model runs presented in Part II of this report supplement data contained in the related FEA reports and give an historical perspective of the overall project effort.

---

[1] The term "environmental residuals" is used synonymously throughout this report with residuals, pollutants, pollution loadings and loadings to describe the 15 categories defined in Section 1.3

CHAPTER ONE

GENERAL DISCUSSION

1.1 Background

In March 1974, the Federal Energy Office announced the President's objective for Project Independence: "...to increase domestic energy supplies and reduce energy demand so as to protect the economy against supply cut-offs and arbitrary price increases." In order to evaluate the effects of the various approaches to the problem, the Project Independence Blueprint (PIB) was developed. This was a massive effort, coordinated by FEA, involving many government agencies, consultants and subcontractors. The process of developing the Project Independence Blueprint is shown graphically in Figure 1-1.

The purpose of the Blueprint was to analyze the effects of alternative government policies on future energy supply and demand and then evaluate the resulting economic, social and environmental impacts. In order to accomplish this, the Federal Energy Administration (FEA) created a Project Independence Evaluation System (PIES) computer model to forecast energy supply and demand for different sets of assumed government policies ("strategies") at different assumed price levels for imported oil. Each combination of strategy and price is called a "scenario."

The FEA PIES model has predicted several scenarios of energy material extraction and conversion (e.g., coal mining, coal-fired power plants, refineries, etc.) for 1985. The FEA model results are presented in computer output form as the FEA PIES Model Report for each scenario.

For analytic purposes the FEA model utilizes different, multistate regions for each energy production and conversion activity. Petroleum Administration Districts (PAD's) are used for refining; Electric Reliability Council Regions first, and later Demand Regions are used for power generation; Coal Supply Regions are used for coal extraction, gasification and liquefaction; Petroleum Supply Regions are used for oil and natural gas production, and Demand Regions

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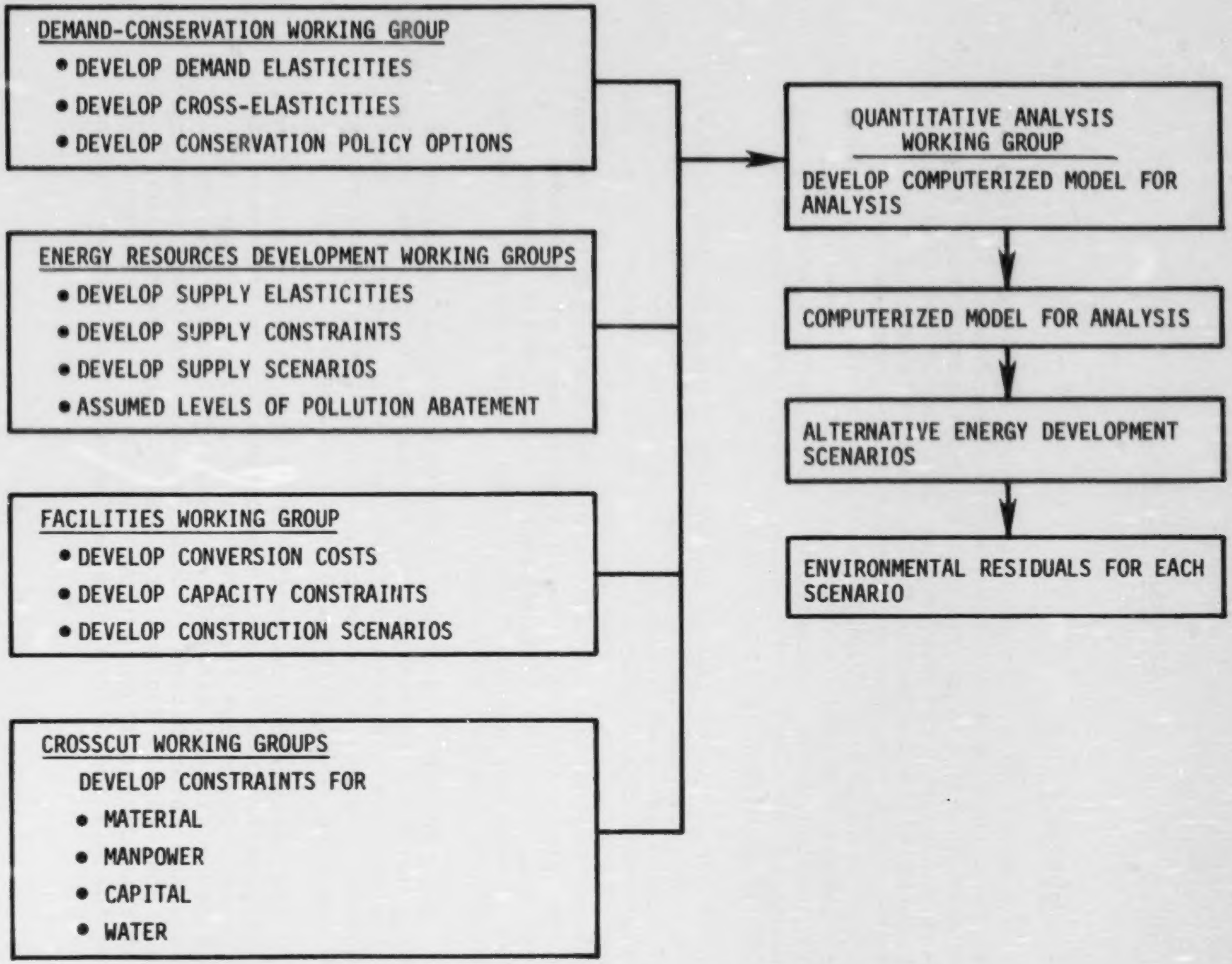
DEMAND-CONSERVATION WORKING GROUP
• DEVELOP DEMAND ELASTICITIES
• DEVELOP CROSS-ELASTICITIES
• DEVELOP CONSERVATION POLICY OPTIONS
ENERGY RESOURCES DEVELOPMENT WORKING GROUPS
• DEVELOP SUPPLY ELASTICITIES
• DEVELOP SUPPLY CONSTRAINTS
• DEVELOP SUPPLY SCENARIOS
• ASSUMED LEVELS OF POLLUTION ABATEMENT
FACILITIES WORKING GROUP
• DEVELOP CONVERSION COSTS
• DEVELOP CAPACITY CONSTRAINTS
• DEVELOP CONSTRUCTION SCENARIOS
CROSSCUT WORKING GROUPS
DEVELOP CONSTRAINTS FOR
• MATERIAL
• MANPOWER
• CAPITAL
• WATER
QUANTITATIVE ANALYSIS WORKING GROUP
DEVELOP COMPUTERIZED MODEL FOR ANALYSIS
COMPUTERIZED MODEL FOR ANALYSIS
ALTERNATIVE ENERGY DEVELOPMENT SCENARIOS
ENVIRONMENTAL RESIDUALS FOR EACH SCENARIO

FIGURE 1-1

PROJECT INDEPENDENCE BLUEPRINT

are used for the end use of energy. These large, multistate regions do not have common boundaries (see Figures 1-2 and 1-3).

One of the PIES model outputs, the FEA Environment Report, is an estimate of pollution loadings for 15 different pollutants from each activity for its corresponding region. The levels of these pollutants are determined by multiplying the energy activity levels by a set of residual coefficients based on the amount of pollutant per fuel unit of activity.[1] The 15 pollutants, or residuals, considered are:

WATER POLLUTANTS	AIR POLLUTANTS	LAND USE
Acids	Particulates	Solid Waste
Bases	Nitrogen oxides	Fixed Land
Total Dissolved Solids	Sulfur oxides	Incremental Land
Suspended solids	Hydrocarbons	
Organics	Carbon monoxide	
Thermal	Aldehydes	

1.2 General Methodology

The purpose of this study was to analyze the environmental impacts of the scenarios generated by FEA's PIES Model. The environmental impact analysis includes:

1. An allocation of pollutants from the FEA regions to smaller regions with common boundaries and a determination of total pollution loadings in the smaller regions;
2. A reaggregation of total pollutant loadings to larger regions for simplicity of presentation. For this report, the FEA Demand Regions were selected in order to be consistent with other aspects of the Project Independence Blueprint;
3. An estimation of the impact of pollutant loadings on ambient environmental quality.

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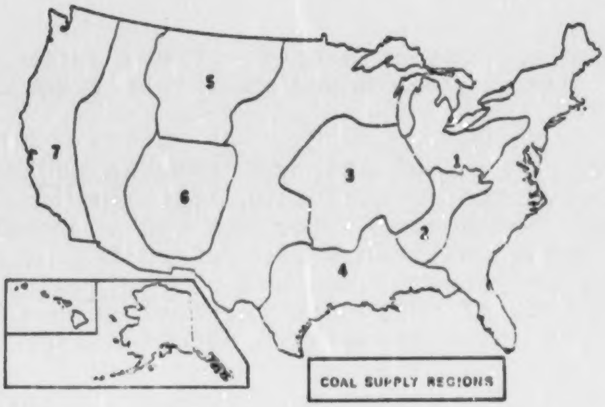
[1] Council on Environmental Quality, Environmental Impacts Efficiency and Cost of Energy Supply and End Use, Final Report HIT 593, prepared by Hittman Associates, November 1974. Revised for EPA, November 1975.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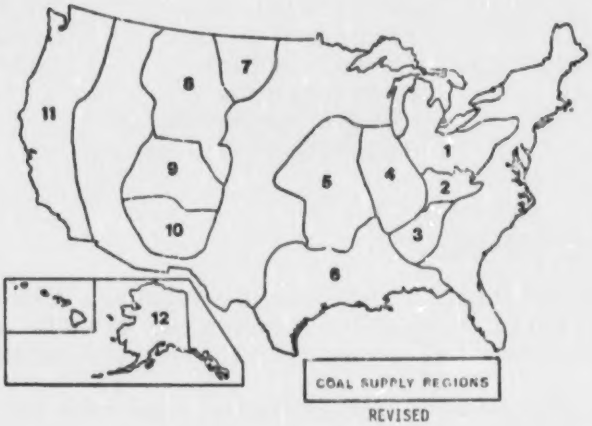
COAL SUPPLY REGIONS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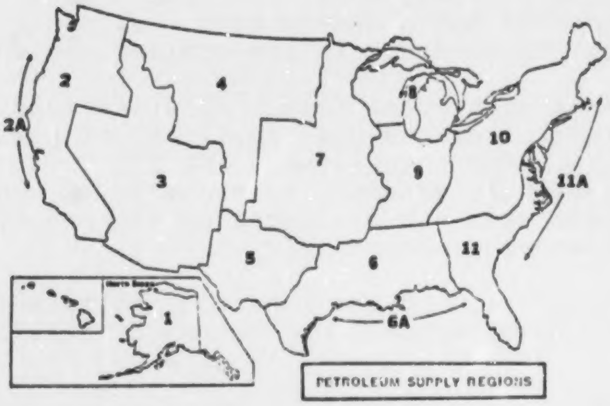
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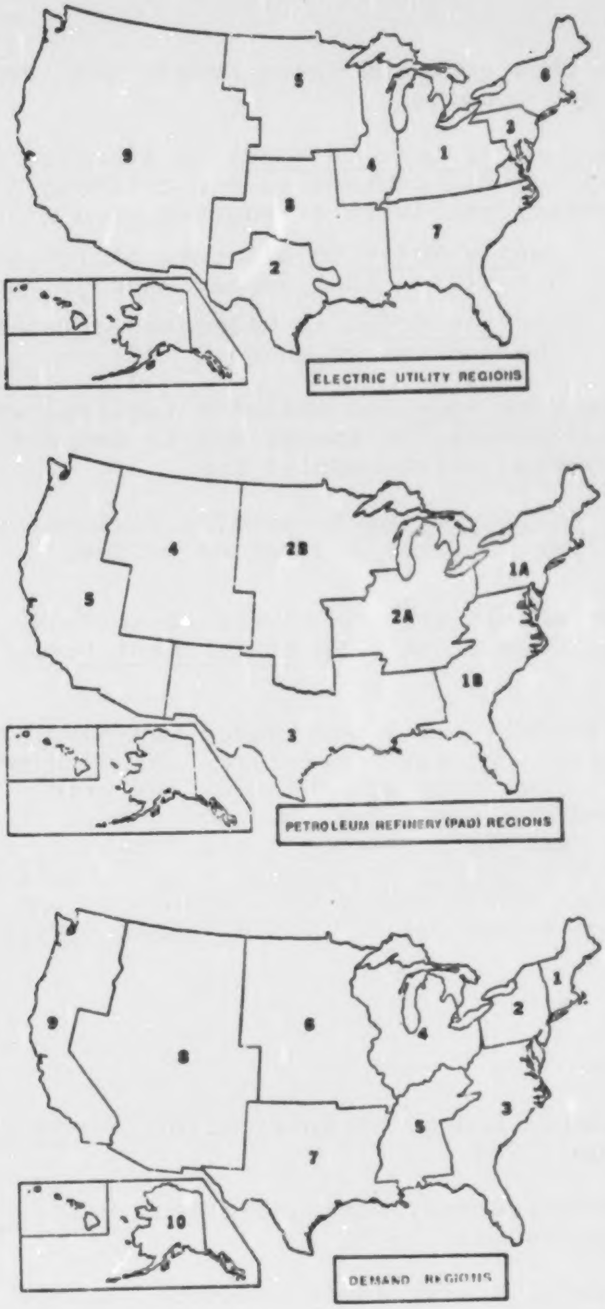
PETROLEUM SUPPLY REGIONS

FIGURE 1-2

FEA SUPPLY REGIONS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ELECTRIC UTILITY REGIONS
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PETROLEUM REFINERY (PAD) REGIONS
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DEMAND REGIONS

FIGURE 1-3

FEA CONVERSION REGIONS

To accomplish this analysis three models were developed, one of which had two modules:

1. Residual Allocation Model to allocate pollutants from the FEA regions to a consistent and smaller boundary set (with a reaggregation capability);
   a. Supply Model to allocate pollutants due to activities that supply energy; and
   b. End-Use Model to allocate pollutants due to the end-use of energy.
2. Water-Use Model to evaluate regional water requirements for energy and to compare with projected water supply; and
3. Air Quality Model to predict regional air quality for particulates and sulfur oxides.

Input to these models are the levels of activity and pollution loadings given in the FEA Environment Report for each scenario.

Originally only the Supply Model was developed due to time constraints. It was, therefore, the only model used for the first three sets of scenarios analyzed. These analyses formed the basis for the environment chapters of the Project Independence Report,[1] the Mandatory Oil Import Program,[2] and the Energy Independence Act[3] reports. Later, the other three models were developed and applied to the last set of scenarios for the National Energy Outlook.[4]

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[1] U.S. Federal Energy Administration, Project Independence Report, November 1974.

[2] U.S. Federal Energy Administration, Mandatory Oil Import Program, January 1975.

[3] U.S. Federal Energy Administration, Energy Independence Act, March 1975.

[4] U.S. Federal Energy Administration, National Energy Outlook, March 1976.

1.3 Definition of Pollutants

For purposes of this study any measureable quantity that is associated with an energy-related activity and which results in an environmental impact is called a residual, pollutant or loading. Residuals are the precursors of environmental impact and not the impact themselves. They are only the first step in the chain: discharge of a pollutant loading, transport and dispersion of the loading affecting ambient concentration, and final impact of the pollutant on health and the environment. An example of this chain would be a power plant emitting SO_2 (loading or residual) affecting ambient concentrations resulting in health effects (impact). This definition avoids the problems and uncertainties of calculating pollution transport and its effect on living organisms by not going beyond the first step.

The following are definitions of pollutants considered in this study. The unit of measurement for each pollutant is also given.

WATER POLLUTANTS:

Acids (equivalent tons of Calcium Carbonate per day to neutralize[1]) - Major sources in 1972 were coal-fired electricity generation and underground and surface coal mining. Acid loadings are assumed to be completely controlled in 1985. Acid drainage from abandoned mines is not included in the loadings.

Bases (equivalent tons of Calcium Carbonate per day[1]) - Major sources in 1985 are underground and surface coal mining, especially from overcontrol of acid water pollution.

Total Dissolved Solids (TDS) (100 tons/day) - Total dissolved solids include acids, bases, phosphates, nitrates and others. Major sources are oil refining, coal-fired electricity generation, and underground and surface coal mining.

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[1] The standard measure of acidity and alkalinity (pH) is not used here because it is a measure of concentration rather than quantity.

Suspended Solids (SS) (tons/day) - Suspended solids include silts and sediments. Major sources are surface and underground coal mining and oil refining.

Organics (100 tons/day) - Organics are organic compounds (hydrocarbons) in water. Major sources are oil production, coal-fired electricity generation and oil refining. Transportation-related oil spills are not considered.

Thermal (billions of Btu/day) - Thermal pollution results from the discharge of heated water from power plants. Major sources are coal-fired, nuclear, oil-fired and natural gas-fired power plants.

AIR POLLUTANTS:

Particulates (tons/day) - Major sources are fuel consumption for industry and transportation and coal-fired electricity generation.

Nitrogen oxides (NO) (tons/day) - Major sources are coal-fired electricity generation and fuel consumption for transportation and industry.

Sulfur oxides (SO) - Major sources are coal- and oil-fired electricity generation, oil refining and fuel consumption for end use.

Hydrocarbons (HC) (tons/day) - Major sources are natural gas production, fuel consumption for transportation, and oil refining.

Carbon monoxide (CO) (tons/day) - The major source is fuel consumption for transportation.

Aldehydes (tons/day) - Aldehydes are a chemically reactive and foul-smelling group of hydrocarbons. Major sources are fuel consumption for transportation and oil refining.

Fixed Land (100 acres) - This is land which is permanently devoted to an energy production activity, mostly for the sites of structures or other facilities. Over 95 percent of fixed land is used for hydroelectric facilities in 1985.

Maximum Incremental Land (100 acres) - Incremental land differs from fixed land in that at any given energy extraction site incremental land changes with time, and does not represent a permanent use of the land. As previously undisturbed land is initially used for energy extraction, it is added to incremental land. As land is reclaimed, it is subtracted from incremental land. Thus, maximum incremental land is the maximum amount of land which has been used for energy material extraction but has not yet been reclaimed. This form of land use in energy production is restricted to underground coal mining (land subsidence), surface coal mining, and oil shale mining. Maximum incremental land does not include land used for solid waste disposal.

1.4 PIES Model Limitations

There are several limitations imposed by the PIES Model. They relate to the assumptions inherent in PIES, and the structure of the PIES output.

1.4.1 Assumptions Related to Pollution Control Technology

Estimates of loadings are very sensitive to the assumed degree of pollution control technology. The 1985 coefficients are developed from the assumptions that existing laws are enforced and that strict surface mining laws are implemented. Specifically, this includes:

1. State Implementation Plans and New Source Performance Standards promulgated under the Clean Air Act are achieved by 1985;
2. Present or anticipated Effluent Guidelines, New Source Performance Standards, and other related regulations promulgated under the Federal Water Pollution Control Act are achieved by 1985;

3. Surface mine reclamation laws requiring regrading to approximate original contour, revegetation, concurrent reclamation, and control of sediment and acid run-off will be implemented by 1985;
4. Vehicle emission control measures are achieved by 1985.

The 1972 coefficients which were applied to levels of energy material extraction and processing were based on the degree to which the 1985 pollution abatement requirements had been implemented in 1972 plus data on uncontrolled pollution from energy activities developed in CEQ Report HIT-561.

1.4.2 Limitations of the Definition of Residuals

The "residual" is a crucial concept with some serious limitations. The 15 residuals allocated by the model define relatively broad classes of environmental impact(Section 1.3). For example, predictions of loadings in organics, measured in hundreds of tons per day, do not distinguish between chemically different hydrocarbons. Loadings estimates for solids, measured in thousands of tons per day, lump together all residuals which do not enter the air or water. They include such different wastes as spent shale from oil shale processing and scrubber sludge from coal-fired power plants. Residuals provide a convenient, allocable set of impact categories by which the overall effects of energy development can be compared.

1.4.3 Items Not Considered

The pollution loadings analyzed herein are only those directly attributable to energy material extraction, processing, and end-use on a per unit of energy basis. Because pollution from other energy-related activities cannot be estimated on the basis of a per unit of energy, pollution loadings do not include pollutants resulting from:

1. Construction of energy facilities; or
2. Secondary development induced by energy development.

Due to technical difficulties, the transportation portion of the FEA model did not operate properly. Thus, loadings from transportation[1] and transmission of energy are not considered.

1.4.4 Uranium Fuel Cycle

The FEA model provides national but not regional pollution loading data for the uranium fuel cycle under the title "U-235 extraction." The loadings include pollutants from all phases of the cycle except nuclear power generation, which is treated separately. These activitiies include mining, milling, uranium hexafluoride production, enrichment, fuel fabrication, reprocessing and waste management. Due to this high level of aggregation, allocation of the pollutants to river basins, AQCR's or Demand Regions was not attempted. Instead, national loadings from these activities are presented separately. The information sources and assumptions utilized in developing the pollution loadings from the uranium fuel cycle were:[2]

1. The source for emission data was "Environmental Survey of the Uranium Fuel Cycle," a report by the U.S. Atomic Energy Commission, April 1974.

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[1] Transportation loadings associated with end-use such as vehicle emissions are considered. Those that are not considered include:

a. Loadings from pipelines (emissions from normal operation, such as pumping and fixed land use as well as spills);

b. Loadings due to chronic and accidental spills of fuel from trucks, trains, barges, tankers and transfer facilities; and

c. Direct emissions of fuels being transported (e.g., particulates from coal being transferred by train; emissions of the train engine are accounted for).

[2] Letter from Hittman Associates to Richard Livingston of EPA, dated November 20, 1974.

2. Extraction emissions are the total of all emissions to the environment due to mining, milling, UF_6 production, enrichment, fuel fabrication, reprocessing, and waste management. Radiation loadings from the wastes of nuclear power plants stored in nuclear waste disposal facilities are not included.

3. Water emissions are those dissolved solids contributed by UF_6 production, enrichment, fuel fabrication, reprocessing, and waste management. Mine drainage is assumed to be pumped to a settling pond for recycle through natural seepage and evaporation. The milling operation is assumed to employ a tailings retention pond for zero water discharge.

4. Air emissions were determined as the total air emissions given in the above reference less those air emissions attributable to the production of electrical energy (consumed by the various operations) by coal-fired power plants.

5. Fixed land impacts were based on 566 acres/annual fuel requirement of a 1000-megawatt plant for the mining exclusion area plus that acreage occupied by the other operations.

Radiation loadings (in curies) were estimated by the FEA model for two activities: U-235 extraction and nuclear power generation. The loadings are those attributable to "normal" operations. No attempt was made to estimate pollution from accidents at any phase of the nuclear fuel cycle. Due to the unique nature of radiation, it was not included with the other pollutants. Instead a separate presentation of radiation was prepared for each scenario.

1.5 Applicability of Results

The analyses performed in this study were confined to the scenarios provided by FEA. Since the objective was to develop a quantitative basis upon which scenarios could be compared, most analysis was confined to consideration of the pollution loadings from the various energy activities predicted in the scenarios. Thus, this study is neither an environmental impact statement nor a broad environmental critique of Project Independence.

The environmental analysis of broad alternative energy strategies cannot be as detailed as an environmental impact statement for a particular facility. The alternative strategies are not site-specific to the degree needed to examine the absolute impacts of emissions on environmental quality. Meteorology and hydrology, current ambient conditions, and pollutants in the area must also be known. While not providing detailed ambient effects, the approach used in this analysis can indicate the relative impacts of alternatives. None of the numbers generated by the model -- including levels of activity, emissions, water use or air quality -- should be considered to be absolute in any sense. Rather, they should be viewed as indices that show relative impacts of different energy associated activities and their corresponding residuals on the environment for different regions. These comparisons may take one of two forms:

1. Comparison of impacts of one scenario on different regions; or
2. Comparison of impacts of different scenarios on one region.

The results of this study present a quantitative method for analyzing some environmental consequences of different national energy policies. They should only be viewed as indicative, not comprehensive.

CHAPTER TWO

METHODOLOGY OF ENVIRONMENTAL ASSESSMENT MODEL FOR PROJECT INDEPENDENCE

2.1 General Description

To analyze the environmental impacts of the various scenarios produced by the Federal Energy Administration's Project Independence Evaluation System Model, three models were developed, one of which had two modules:

1. Residual Allocation Model to allocate pollutants from the FEA regions to a consistent and smaller boundary set (with a reaggregation capability);
    a. Supply Model to allocate pollutants due to activities that supply energy; and
    b. End-Use Model to allocate pollutants due to the end-use of energy.
2. Water-Use Model to evaluate regional water requirements for energy, using activity projections generated by the Residual Allocation Models, and to compare with projected water supply; and
3. Air Quality Model to predict regional air quality for particulates and sulfur oxides from output of the Residual Allocation Model.

Figure 2-1 shows the relationship of these models to one another. The outputs of the models developed were constrained by the type of data, level of detail and geographic definitions of the FEA model. Although the analytic models described can be modified in order to accomodate other types of energy development scenarios, so far they have been oriented entirely toward the FEA model.

The purpose of these models is to aggregate loadings of the fifteen selected pollutants defined in Section 1.3 into common geographic areas so that the total impacts of these loadings can be analyzed. The analysis involves six stages:

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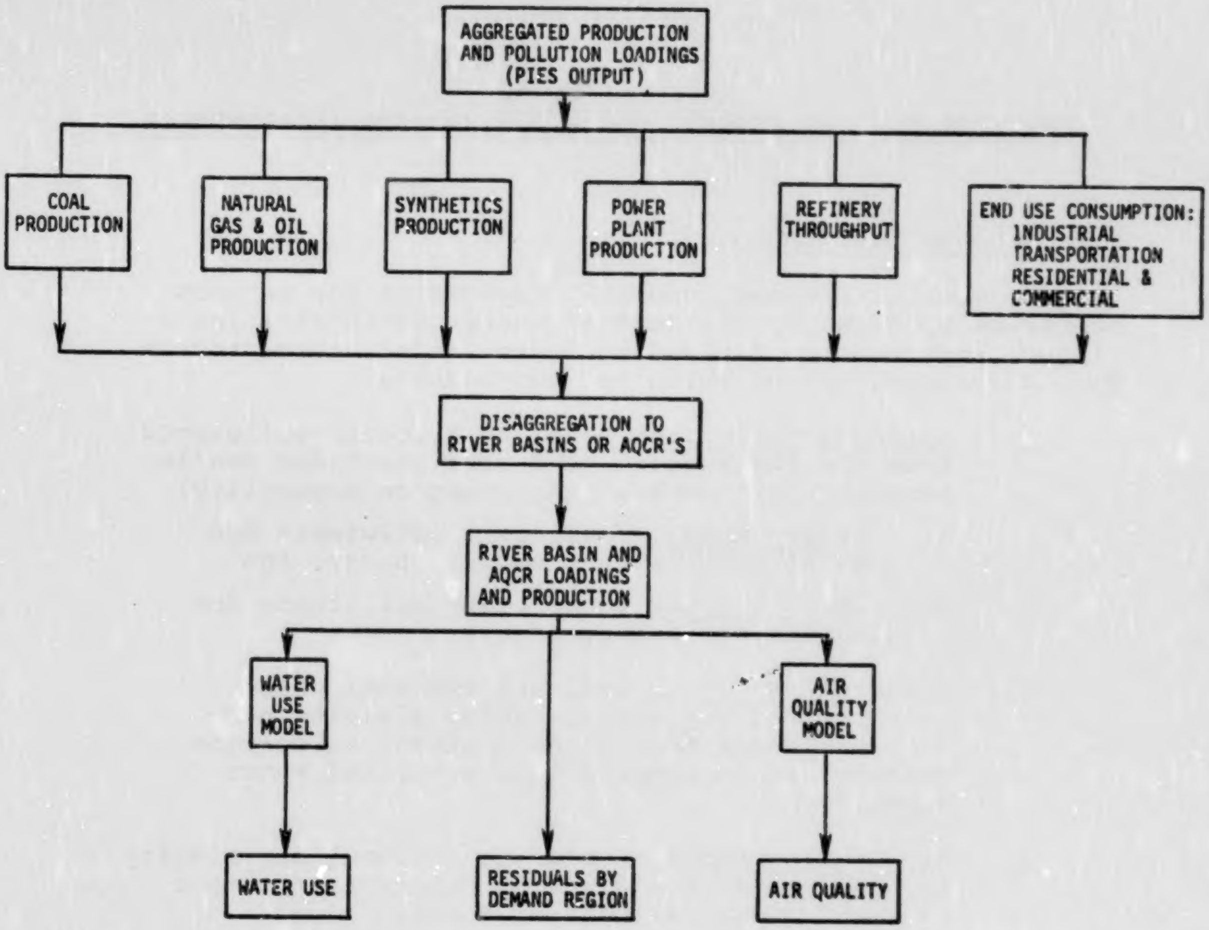

AGGREGATED PRODUCTION AND POLLUTION LOADINGS (PIES OUTPUT)
COAL PRODUCTION
NATURAL GAS & OIL PRODUCTION
SYNTHETICS PRODUCTION
POWER PLANT PRODUCTION
REFINERY THROUGHPUT
END USE CONSUMPTION: INDUSTRIAL TRANSPORTATION RESIDENTIAL & COMMERCIAL
DISAGGREGATION TO RIVER BASINS OR AQCR'S
RIVER BASIN AND AQCR LOADINGS AND PRODUCTION
WATER USE MODEL
AIR QUALITY MODEL
WATER USE
RESIDUALS BY DEMAND REGION
AIR QUALITY

FIGURE 2-1

FLOW CHART FOR RESIDUAL ALLOCATION MODEL

1. The FEA computer model predicts energy activities and resulting pollution loadings for geographic regions defined by FEA. These geographic regions are different for each energy activity and do not reflect environmental considerations;
2. The production and pollution loadings from the FEA model are allocated to smaller regions defined by environmental features (river basins or Air Quality Control Regions, AQCR's) by the Residual Allocation Models (Supply and End-Use) described below. This enables calculation of total pollution loadings for a given geographic area;
3. The impacts of pollution loadings are analyzed at the river basin level, the AQCR level, or at a higher level of reaggregation;
4. Predicted Loadings are compared to 1972 loadings by activity or by area;
5. The impacts of energy activity on water supply in Aggregated Sub-Areas (ASA's) are assessed; and
6. Scenario impacts on ambient air quality are estimated for each AQCR.

Table 2-1 shows the assumptions of the Residual Allocation Models.

2.2 Supply Model

2.2.1 General Model Description

The PIES Model output contains scenario-related residual loadings for each energy activity in multi-state-sized regions which differ from activity to activity. This kind of information is not readily adaptable to the evaluation of relative environmental impacts, for the areas used are too large to resolve more localized regional effects, and they are too inconsistent to admit comprehensible summary. In order to circumvent these difficulties, the Supply Model disaggregates the energy-related, activity-specific pollution loadings generated by the PIES Model down to smaller regions defined by environmental considerations (i.e., 335 river

TABLE 2-1

ASSUMPTIONS OF RESIDUAL ALLOCATING MODELS

SUPPLY MODEL

1) Surface and underground mining activity from existing mines is directly proportional to 1972 surface and underground mining activity respectively.

2) Surface and underground mining activity from new mines is directly proportional to 1972 known levels of reserves.

3) Oil and natural gas production is directly proportional to capacities of known reserves.

4) Synthetic fuel production is directly proportional to capacities of proposed plants.

5) Oil shale development is directly proportional to levels of reserves.

6) Power plants and refinery production is directly proportional to projected 1983 activity.

END-USE MODEL (RIVER BASIN ALLOCATION)

1) Industrial fuel use by two digit SIC activity in each census region is directly proportional to the 1972 distribution, the four digit SIC fuel use within each two digit SIC is directly proportional to the 1972 national distribution and finally the river basin fuel use is directly proportional to the number of employees by four digit SIC in 1972.

2) Transportation

    a. Jet fuel use is directly proportional to the number of jet takeoffs in 1972.

    b. Fuel for shipping is directly proportional to tonnages shipped in 1972.

    c. Distillate fuel use for railroads is directly proportional to 1972 primary track mileage.

    d. Distillate fuel use for trucks and buses is directly proportional to a linear regression defined function of 1972 interstate highway mileage and population.

    e. Gasoline use by state is directly proportional to 1972 state consumption and within states, directly proportional to 1972 population.

3) Residential/commercial fuel use is directly proportional to 1972 population.

END-USE MODEL (AQCR ALLOCATION)

1) Fuel use by state within a Census Region is directly proportional to 1972 fuel consumption.

2) Industrial fuel use by AQCRs within a state is directly proportional to 1972 industrial hydrocarbon emissions from that fuel.

3) Transportation fuel use by AQCRs within a state is directly proportional to 1972 transportion related particulate emissions from that fuel.

4) Residential/commercial fuel use by AQCRs within a state in directly proportional to 1972 population.

basins and 243 AQCR's) and then sums these over the set of all activities to obtain the total pollution loadings in each of those regions.

The energy supply activities considered by the PIES model are:

- surface coal mining from existing and new mines
- underground coal mining from existing and new mines
- oil production
- natural gas production and processing
- oil extraction from oil shale
- synthetic production of fuels
    - high Btu coal gasification
    - low Btu coal gasification
    - coal liquefaction
- refinery production
- electric power generation
    - coal-fired
    - oil-fired
    - natural gas-fired
    - simple cycle turbines
    - combined cycle turbines
    - nuclear
    - hydroelectric

The 335 river basins are those defined by the National Oceanographic and Atmospheric Administration. The 243 Air Quality Control Regions are defined by the Environmental Protection Agency. They were selected because they are convenient, readily available, universally recognized national geographic definitions, and they form a consistent subset of all PIES regions. They also minimize the problems of overflowing pollution from one area to another. The regions are small enough to allow aggregation by energy activities, but not so small as to stretch unnecessarily the accuracy of the model. A map of the river basins is presented in Figure 2-2, and an index of river basin names is presented in Appendix B as Table B-1. A map and index of AQCR's are presented as Figure 2-3 and Table B-2.

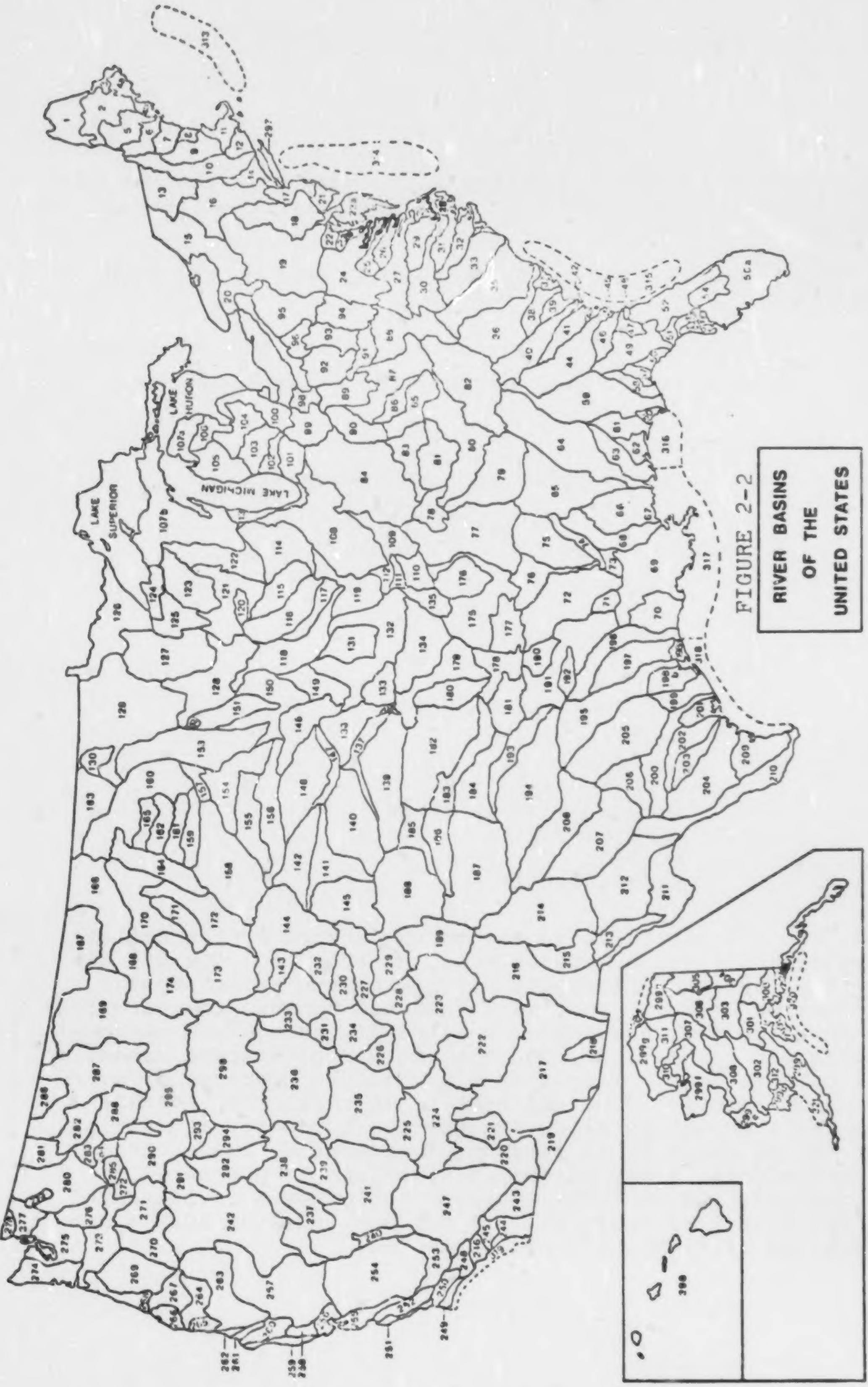

LAKE SUPERIOR
LAKE HURON
LAKE MICHIGAN

FIGURE 2-2

RIVER BASINS OF THE UNITED STATES

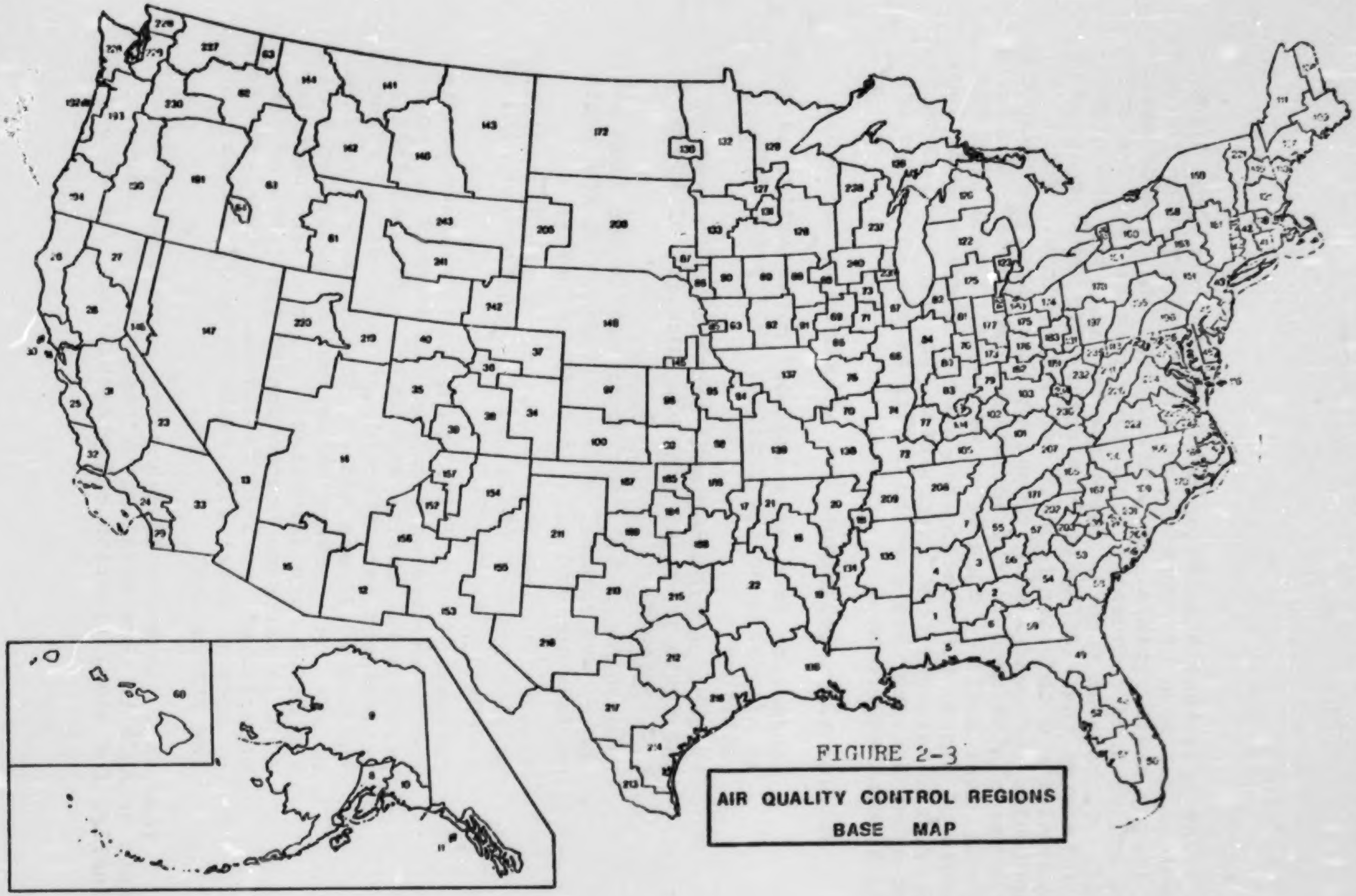


FIGURE 2-3

AIR QUALITY CONTROL REGIONS BASE MAP

The pollutant allocation scheme is based on the known location and size of deposits and current production patterns of energy raw materials, and the location and size of existing and planned conversion facilities (see Figures 2-4 and 2-5). Surrogates such as these are required for the allocation because the PIES Model does not predict the location of any activity within its broadly defined regions. These particular surrogates were chosen because they represent the best correlated data to the activities considered, available at the river basin or AQCR level of detail. Data from the Bureau of Mines, U.S. Geological Survey, American Petroleum Institute, National Coal Association, Federal Power Commission and other sources were used to determine the locations for the allocation schemes.

Specifically, pollutants are allocated as follows:

- Production from existing coal mines active in 1972 is allocated on the basis of 1972 production patterns;
- Production from new coal mines is allocated on the basis of size, type and location of known coal deposits;
- Production of oil (including extraction from oil shale) and natural gas is allocated on the basis of location and size of known reserves;
- Production from coal gasification and liquefaction is allocated on the basis of location and size of proposed plants; and
- Conversion facilities which include power plants and refineries were mapped and located in appropriate river basins and AQCR's. Planned facility retirements were removed and proposed new plants through 1983 were added. The 1985 loadings from an FEA fuel conversion region, as predicted by the FEA model, are allocated to each river basin and AQCR in the same proportion as the ratio of the capacity of the 1983 facilities in the river basin or AQCR to total 1985 capacity of facilities in the FEA region.

Then, all the above loadings are aggregated by river basin or AQCR to form total river basin or AQCR loadings. Finally, for simplification and presentation, FEA Demand

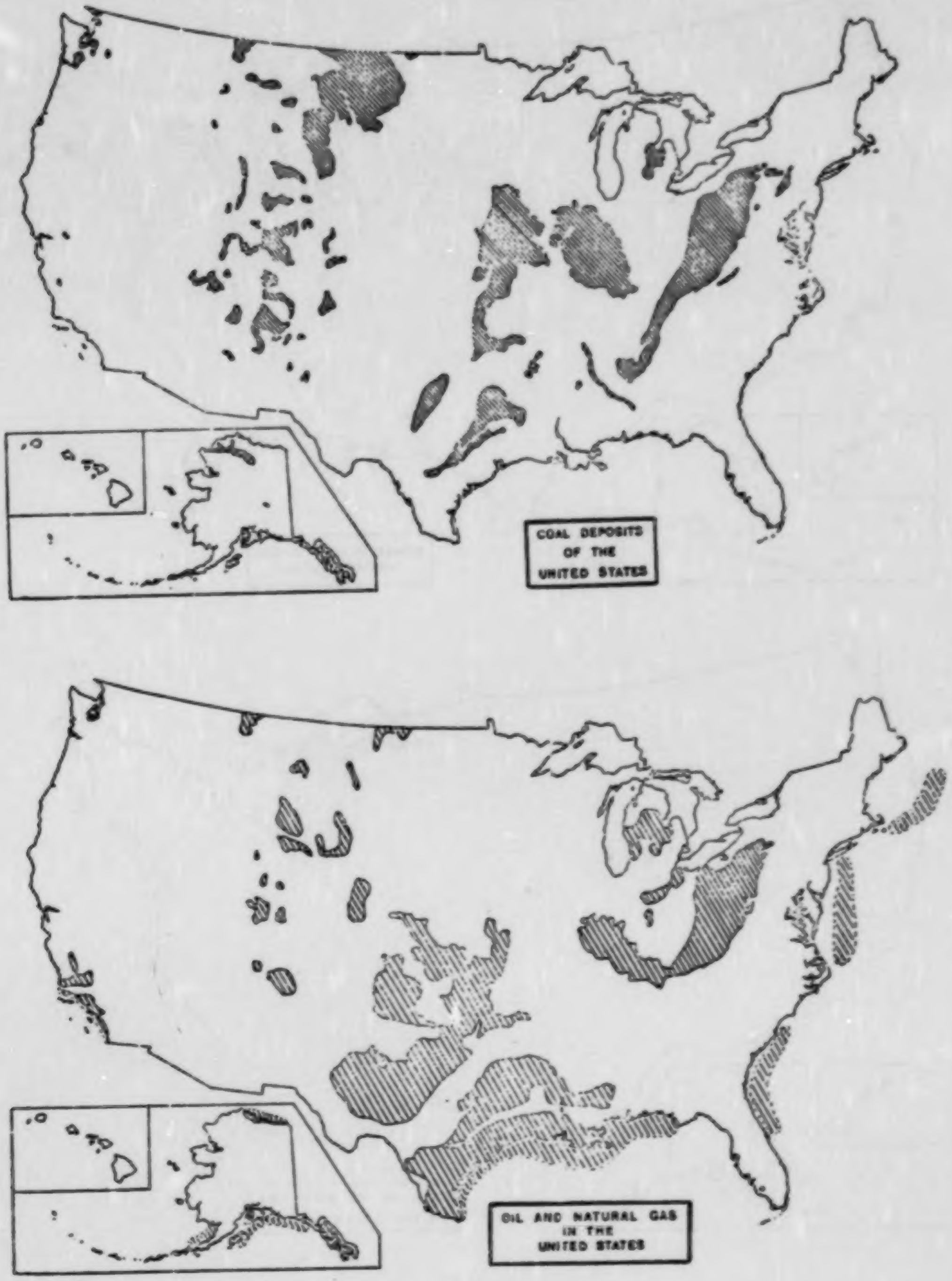
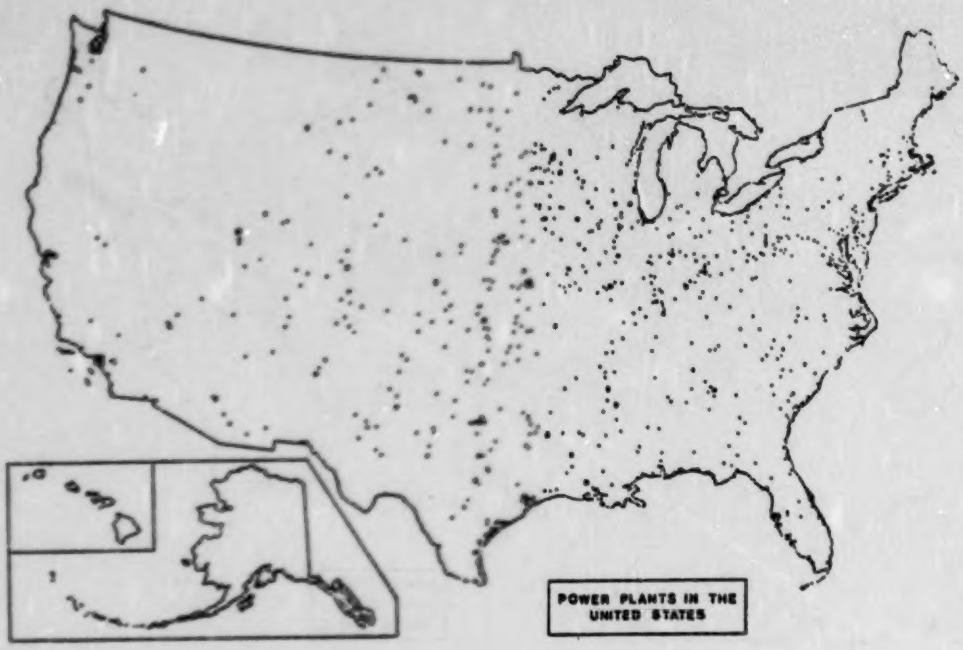

COAL DEPOSITS OF THE UNITED STATES
OIL AND NATURAL GAS IN THE UNITED STATES

FIGURE 2-4

FOSSIL FUEL DEPOSITS


POWER PLANTS IN THE UNITED STATES

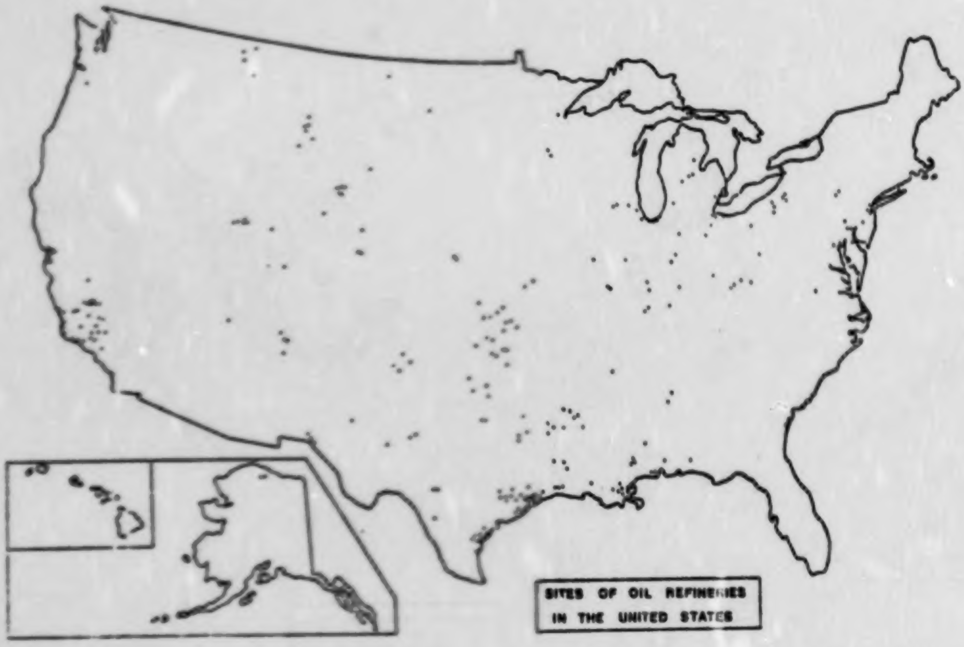

SITES OF OIL REFINERIES IN THE UNITED STATES

FIGURE 2-5

CONVERSION FACILITIES

Region loadings are determined by aggregating the loadings of the river basins or AQCR's in each Demand Region. In the end, loadings -- due to the supply of energy by river basin, AQCR and Demand Region -- are available in total and for each energy activity.

2.2.2 Detailed Model Description

For purposes of the following discussion, river basins were used as the basic geographic unit. However, the allocation model for AQCR's follows exactly the same scheme. Table 2-2 defines the symbols that are used in the equations below.

The amount of loadings k (k=1 to 15) due to activity m (m=1 to 18) in FEA Supply Region i (i=1 to 7,9 or 14) is defined by:

$$A_{ikm} = E_{im} \cdot P_{ikm} , \tag{2-1}$$

where E_{im} is the level of activity m in FEA Supply Region i, and P_{ikm} is the residual coefficient[1] for residual k, activity m in FEA Supply Region i.

Then the amount of loadings k due to activity m in river basin j (j=1 to 335) is given by:

$$L_{jkm} = A_{ikm} \cdot F_{ijm} \tag{2-2}$$

where F_{ijm} is the fraction of production of activity m in FEA Supply Region i allocated to river basin j.

Then the total amount of residual k in river basin j is just the sum over all activities in the river basin,

$$R_{jk} = \sum_{m} L_{jkm} . \tag{2-3}$$

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[1] Hittman Associates, Inc., Summary Report of the Pollutants Associated with the Resource Activities of the Hittman Environmental Coefficient Matrices, for the U.S. Environmental Protection Agency under Contract No. 68-01-2461, December 1974.

TABLE 2-2

KEY TO EQUATION SYMBOLS FOR RESIDUAL ALLOCATION MODEL

MATRIX ELEMENTS	DEFINITION
A_{ikm}	Residual levels by activity and FEA region
E_{im}	Activity levels by FEA region
P_{ikm}	Residual coefficients by activity and FEA region
L_{jkm}	Residual levels by activity and river basin
F_{ijm}	Allocation factor of FEA region to river basin by activity
R_{jk}, R_{im}	Total residual levels summed over activities
S_{jm}, S_{im}	Surrogate levels defining F
C_{ims}	Fuel consumption by 2-digit SIC and Census Region
B_{tm}	National fuel consumption by 4-digit SIC
N_{jt}	Numbers of industrial employees by 4-digit SIC and river basin
X_{jh}	Allocation factor of county to river basin
G_w	Gasoline consumption by state
P_h	Population by county
J_j	Jet takeoffs by river basin
V_{iu}	Consumption of distillate by transportation use and Census Region
T_{iu}	Transportation distillate surrogate by river basin and use
I_w	Interstate highway mileage by state
D_w	State consumption of distillate for trucks
H_j	Tonnage shipped by river basin
O_j	Population by river basin
Z_{wm}	Fuel consumption by state and category

INDICES	DEFINITION
i	FEA region
k	Residual
m	Activity or fuel consumption category
j	River basin (AQCR)
s	2-digit SIC code
t	4-digit SIC code
h	County
u	Uses of distillate for transportation
w	State

The A_{ikm}'s are output of the PIES Model. The main problem in assembling the model, then, is to determine the allocation factor, F_{ijm}.

$F_{ijm} = 0$ if river basin j is not contained in FEA Supply Region i. Otherwise, F_{ijm} is uniquely defined by activity, river basin, and FEA Supply Region as follows:

A) For fossil fuel extraction

1. for underground coal extraction from existing (1972) mines, m = 1:

$$F_{ij1} = \frac{\text{1972 underground coal extraction in river basin j}}{\text{1972 underground coal extraction in FEA Coal Supply Region i}}$$

2. for underground coal extraction from new mines, m = 2:

$$F_{ij2} = \frac{\text{1972 reserves of underground coal in river basin j}}{\text{1972 reserves of underground coal in FEA Coal Supply Region i}}$$

3. for surface coal extraction from existing (1972) mines, m = 3:

$$F_{ij3} = \frac{\text{1972 surface coal extraction in river basin j}}{\text{1972 surface coal extraction in FEA Coal Supply Region i}}$$

4. for surface coal extraction from new mines, m = 4:

$$F_{ij4} = \frac{\text{1972 reserves of surface coal in river basin j}}{\text{1972 reserves of surface coal in FEA Coal Supply Region i}}$$

5. for oil production, m = 5:

$$F_{ij5} = \frac{\text{1972 reserves of oil in river basin j}}{\text{1972 reserves of oil in FEA Petroleum Supply Region i}}$$

6. for natural gas production, m = 6:

$$F_{ij6} = \frac{\text{1972 reserves of natural gas in river basin j}}{\text{1972 reserves of natural gas in FEA Petroleum Supply Region i}}$$

7. for oil from oil shale, m = 7:

$$F_{ij7} = \frac{\text{1972 reserves of oil shale in river basin j}}{\text{1972 national reserves of oil shale}}$$

(for oil from oil shale the PIES Model only generates national production levels.)

B) For facilities and synthetic fuels, m = 8 to 18

$$F_{ijm} = \frac{\text{Existing capacity - retiring capacity + proposed capacity of activity m in river basin j}}{\text{Existing capacity - retiring capacity + proposed capacity of activity m in FEA Supply Region i}}$$

Finally, to aid the comprehension and presentation of the results, the river basin loadings are aggregated to Demand Regions. So, for all river basins j in Demand Region i,

$$R_{ik} = \sum_{i\varepsilon j} R_{jk} \quad . \qquad (2\text{-}4)$$

2.3 End-Use Model

2.3.1 General Model Description

In order to assess the full environmental impact of various energy scenarios, it is necessary to estimate pollution loadings, not only from the production and supply of energy sources, but also from the end-uses of these sources. The End-Use Model was developed to compute these pollution loadings in order that they can be added to the loadings from the supply model.

An end-use scenario consists of a set of fuel consumption data and associated pollution loadings for each of the nine FEA-defined Census Regions (see Figure 2-6). In order to distinguish between different categories of uses for certain fuels, consumption is divided among three sectors as shown in Table 2-3.

The task of the model is to disaggregate the input Census Region data down to the river basin or AQCR level. The variety of activities included in the consideration of

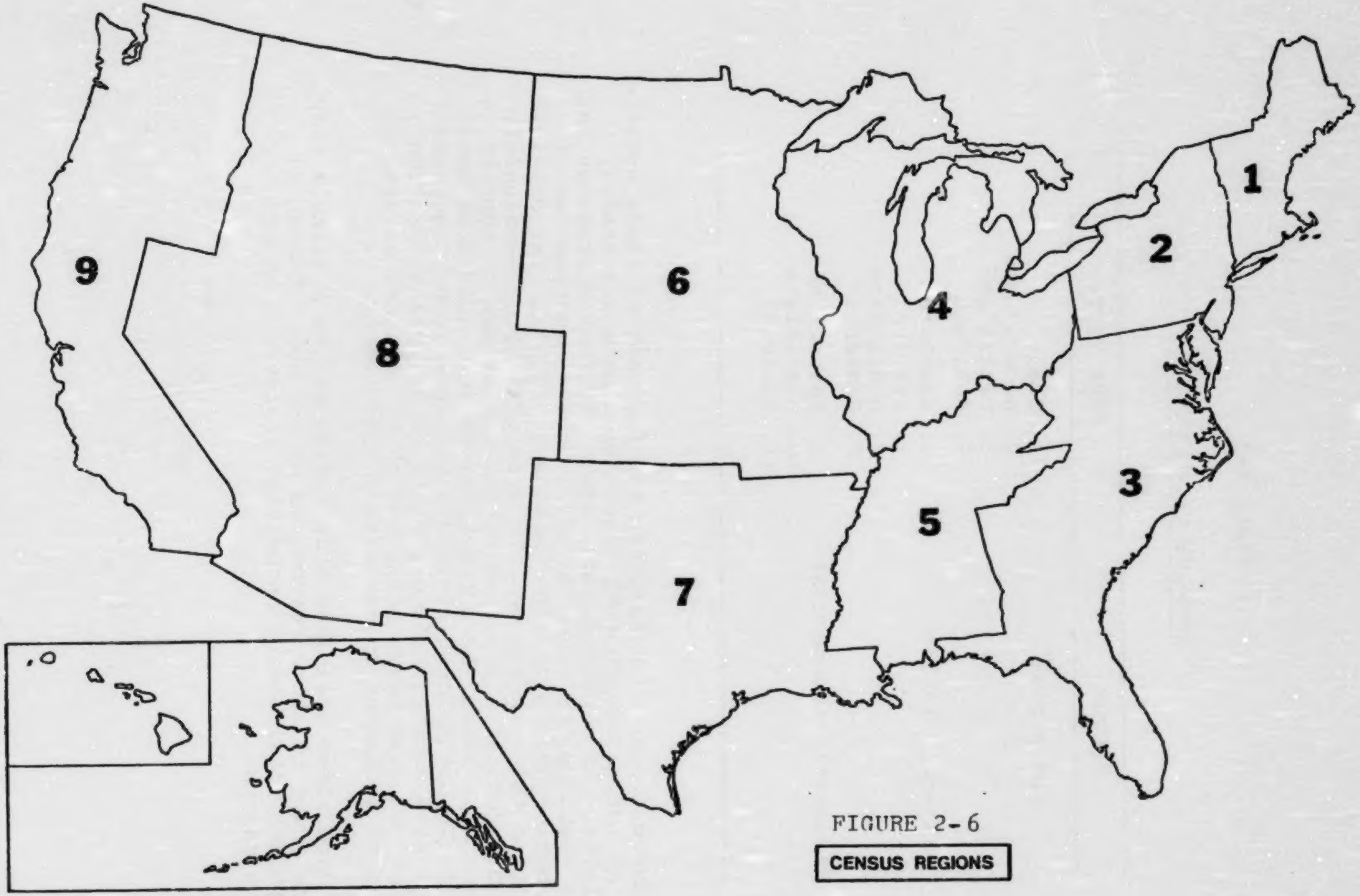

FIGURE 2-6

CENSUS REGIONS

TABLE 2-3

END-USE CATEGORIES

SECTOR	FUEL TYPE
Industrial	1. Coal 2. Natural gas 3. Distillate 4. Residual
Transportation	5. Gasoline 6. Jet fuel 7. Distillate 8. Residual
Residential/Commercial	9. Natural gas 10. Distillate 11. Residual

end-use patterns is extensive, and for most of these activities no comprehensive fuel consumption data are readily available. As a consequence, many different surrogates had to be tabulated in order to effect the disaggregation of consumption levels to river basins or AQCR's. The critical factor in this process was the availability of meaningful, reliable data at a level of detail sufficient to support the allocation. Since, as a practical matter, some data bases are finely partitioned along one variable (e.g., industrial category) and others along another (e.g., plant location), a number of data bases often had to be combined or used in series to determine an activity's distribution.

Once river basin and AQCR estimates are available they may be added to those forecasted by the supply model to obtain the total energy-associated residual loadings for each scenario.

2.3.2 River Basin Disaggregation Module

Consumption of each fuel type is assumed to follow the same distribution over the set of river basins within each census region as in the base year, 1972. Since actual consumption data are rarely available by river basins, this model assumes that fuel consumption is related in some way (usually proportionally) to such surrogates as population, number of employees, etc. The allocation is of the same form as the Supply Model:

$$A_{ikm} = E_{im} \cdot P_{ikm} \text{ and} \tag{2-1}$$

$$L_{jkm} = A_{ikm} \cdot F_{ijm} \tag{2-2}$$

where E_{im} is the level of consumption of fuel category m in Census Region i,

P_{ikm} is the residual coefficient[1] for residual k, fuel category m in Census Region i,

A_{ikm} is the amount of residual k due to consumption of fuel m in Census Region i, and

F_{ijm} is the fraction of consumption of fuel m in Census Region i allocated to river basin j.

Then the total amount of residual k in river basin j caused by the end-use of energy is

$$R_{jk} = \sum_{m} L_{jkm} . \tag{2-3}$$

The A_{ikm}'s are output by the PIES Model. The problem is to determine the allocation factor, F_{ijm}.

$F_{ijm} = 0$ if river basin j is not contained in Census Region i. Otherwise, F_{ijm} is defined by one or more surrogates, S_{jm}, for the consumption of fuel m and is of the form:

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[1] Hittman Associates, Inc., Environmental Pollution Coefficients for Fossil Fuel End Use in the Transportation, Industrial and Residential/Commercial Sector, May 1975.

$$F_{ijm} = \frac{S_{jm}}{S_{im}} \qquad (2\text{-}5)$$

where S_{jm} is the amount of surrogate quantity for activity m in river basin j, and

S_{im} is the amount of surrogate quantity for activity m in Census Region i. ($S_{im} = \sum_{j\varepsilon i} S_{jm}$)

2.3.2.1 Industrial Sector (m = 1,2,3,4)

The allocation is based on the 1972 Census of Manufacturers[1] data for the six most energy-intensive 2-digit Standard Industrial Classification (SIC) industries (see Table 2-4). (Petroleum refining and the electric utility industry are treated in the Supply Model.)

Industrial fuel consumption data are available at the state level by 2-digit SIC, but at no finer level. Therefore, a second surrogate is required to allocate state consumption to river basins. The number of employees seems best to satisfy the availability and suitability requirements. However, since the relationship of fuel mix and consumption patterns to employment levels varies significantly even within 2-digit SIC groups, it is desirable to allocate statewide industrial fuel consumption to river basins according to the number of employees in each river basin within each 4-digit SIC.

Finally, since state fuel consumption data are not available by 4-digit SIC, it is necessary to split the 2-digit consumption data to 4-digit SIC's. This is accomplished using the national distribution of 4-digit SIC fuel consumption. In this case, then, the surrogates are really a series of three surrogates:

---

[1] U.S. Department of Commerce, Bureau of the Census, 1972 Census of Manufacturers, National Consumption of Fuels by SIC, 1972, 1974.

TABLE 2-4

SIC CODE ASSIGNMENTS

s	t	SIC CODES
1	1	201, 202
	2	205-207
	3	203, 208
	4	204, 209
2	5	261-263, 266
	6	264, 265
3	7	2812, 2813, 2816 2817, 2872, 2819
	8	2815, 2818, 282-284, 289, 2879, 2851, 2861
4	9	3281, 329
	10	325, 326
	11	321-323
	12	3241, 327
5	13	3312
	14	332
	15	3331
	16	333
	17	3334
6	18	3711-3713
	19	3714

$$F_{ijm} = \sum_{t=1}^{19} \frac{C_{ims}}{\sum_{s=1}^{6} C_{ims}} \frac{B_{tm}}{\sum_{t \varepsilon s} B_{tm}} \frac{N_{jt}}{\sum_{j \varepsilon i} N_{jt}} \qquad (2\text{-}6)$$[1]

where C_{ims} is the 1972 consumption of fuel m for 2-digit SIC s in Census Region i,

B_{tm} is the 1972 national consumption of fuel m for 4-digit SIC t, and

N_{jt} is the 1972 number of employees in river basin j for SIC t.

The first term allocates total industrial consumption of fuel m in Census Region i to consumption due to 2-digit SIC s. The second term allocates consumption of fuel m for 2-digit SIC s to consumption for 4-digit SIC t. The last term allocates 4-digit SIC t consumption of fuel m in Census Region i to river basin j. Summing over the 19 4-digit SIC's gives the total industrial consumption allocation factor for fuel m.

2.3.2.2 Transportation Sector (m = 5,6,7,8)

Again fuel consumption data is unavailable beyond the state level so further surrogates are necessary to disaggregate consumption to river basins.

---

[1] A problem arises in Census Regions where one or more of the 4-digit industry classes has no employees, i.e., $N_{jt}=0$ for all j. In this case, equation 2-6 will assign a zero to the denominator of the summand, causing an obvious difficulty in the computational routine. What is desired in such cases is that no fuel consumption be assigned to the industries in question, so if Census Region i has no employees in 4-digit SIC group t, the model sets

$$\frac{N_{jt}}{\sum_{j \varepsilon i} N_{jt}} = 0$$

for all $j \varepsilon i$. The problem does not arise with the B_{tm}, since all industries consumed all fuels in each Census Region in 1972. Similarly in the transportation sector, F_{ijm} is set to zero if any surrogate equals zero.

A) Gasoline (m=5). Consumption is assumed proportional to population within each state. Since population data is available by county but not by river basin, a county-to-river basin allocation scheme apportions the area of each county among the various river basins which intersect it. This will henceforth be denoted by

X_{jh} = fraction of county h's area assigned to river basin j.

The gasoline allocation factor is then

$$F_{ij5} = \sum_{h\varepsilon j} \frac{G_w}{\sum\limits_{w\varepsilon i} G_w} \cdot \frac{P_h}{\sum\limits_{h\varepsilon w} P_h} \cdot X_{jh} \qquad (2\text{-}7)$$

where G_w is the 1972 consumption of gasoline in state w, and
P_h is the population of county h.

The first factor allocates Census Region gasoline consumption to state. The second factor allocates state consumption to county. Multiplying by X_{jh} and summing over all counties intersecting river basin j allocates county consumption to that river basin.

B) Jet fuel (m=6). The surrogate for jet fuel use is the number of jet takeoffs, so

$$F_{ij6} = \frac{J_j}{\sum\limits_{j\varepsilon i} J_j} \qquad (2\text{-}8)$$

where J_j is the number of 1972 jet takeoffs in river basin j.

C) Distillate (m= 7). Distillate is first split among the three main uses of that fuel for transportation (trains, ships and highway) and then allocated to river basin by surrogates specific to those uses. Thus,

$$F_{ij7} = \sum_{u=1}^{3} \frac{V_{iu}}{\sum\limits_{u=1}^{3} V_{iu}} \; \frac{T_{ju}}{\sum\limits_{u\varepsilon i} T_{ju}} \qquad (2\text{-}9)$$

where V_{iu} is the 1972 consumption of distillate for use u in Census Region i (so that the first factor is the fraction of total distillate consumption due to use u) and T_{ju} is the surrogate to allocate consumption due to use u to river basin j.

For trains T_{ju} is the amount of primary track mileage in river basin j (except in Alaska where all tracks are classified as secondary). For ships T_{ju} is the amount of 1972 vessel bunkering in each river basin.

For highway use, consumption is assumed to be proportional to a linear combination of the logarithm of population and interstate mileage (I_w) within each state, i.e., if D_w is the 1972 state w consumption of distillate by trucks, then

$$D_w = a_i \sum_{h \varepsilon w} \log P_h + b_i I_w \quad . \tag{2-10}$$

(This relationship gave the best fit of all log or linear combinations at the Census Region level.)

The coefficients a_i, b_i are computed for each Census Region by multiple linear regression, so that the sets of ordered triples $\{ \sum_{h \varepsilon w} \log P_h, I_w, D_w): k \varepsilon i\}$ are assumed to be closely approximated by a plane passing through the origin.

Since the regression is linear, the coefficients a_i, b_i may be applied to logarithms of county populations (P_h) and interstate mileages (I_h) to estimate 1972 county consumption of distillate for highway use:

$$D_h = a_i \log P_h + b_i I_h \quad . \tag{2-11}$$

Using the county-to-river basin allocation, for highways

$$T_{ju} = \sum_{h \varepsilon j} D_h \cdot X_{jh} \quad . \tag{2-12}$$

D) Residual (m=8). The surrogate for transportation residual consumption is the tonnage shipped in each region. The allocation factor for residual oil is then

$$F_{ij8} = \frac{H_j}{\sum\limits_{j\varepsilon i} H_j} \tag{2-13}$$

where H_j is the amount of tonnage shipped in river basin j.

2.3.2.3 Residential/Commercial Sector

Consumption of all three fuels (m = 9,10,11) is assumed proportional to population. If P_h is the 1972 population for county h, then, using the county-to-river basin allocation,

$$O_j = \sum_{h\varepsilon j} P_h \cdot X_{jh} \tag{2-14}$$

is the estimated population of river basin j. The allocation factor is therefore

$$F_{ijm} = \frac{O_j}{\sum\limits_{j\varepsilon i} O_j} \tag{2-15}$$

2.3.3 AQCR Disaggregation Module

A slight variation on the river basin allocation model is possible for AQCR's. Here the surrogate allocation parameters can be actual 1972 emissions by AQCR from the 1972 National Emissions Report.[1] If Z_{wm} is the 1972 consumption of fuel m in state w and S_{jm} is the surrogate in AQCR j of fuel m, then the allocation factor is

---

[1] U.S. Environmental Protection Agency, 1972 National Emissions Report, National Emissions Data System of the Aerometric and Emissions Reporting System, EPA-450/2-74-012, June 1974.

$$F_{ijm} = \frac{Z_{wm}}{\sum\limits_{w \epsilon i} Z_{wm}} \cdot \frac{S_{jm}}{\sum\limits_{j \epsilon w} S_{jm}} \qquad (2\text{-}16)$$

The first term allocates Census Region consumption to state. The second allocates state consumption to AQCR.

For industrial fuel use (m=1 to 4) the surrogate used is hydrocarbon emissions. They are less sensitive to pollution control technology[1] (which may be employed non-uniformly in different AQCR's within a state) than particulates, sulfur oxides and nitrogen oxides, and they are generally larger than carbon monoxide emissions, therefore yielding more accurate fractions. For transportation fuel use (m=5 to 8) the surrogate used is particulates because they are generally larger than the other emissions and, within a state, transportation pollution control techniques probably will be employed in a relatively uniform manner by 1985. For residential/commercial fuel use (m=9 to 11) population remains the surrogate measure.

2.4 Water-Use Model

2.4.1 Introduction

The demand of future energy development for the nation's water supply, particularly in certain regions of the country, may cause significant disruptions for both man and nature. Man's non-energy related use of water may be curtailed or restricted to provide enough water for energy activities in regions where water demand is near supply levels and energy resources are plentiful. In regions where water supply is adequate to support man's activities including future energy development, the impact of reduced water supply on the environment and ecological balance may still be an important consideration.

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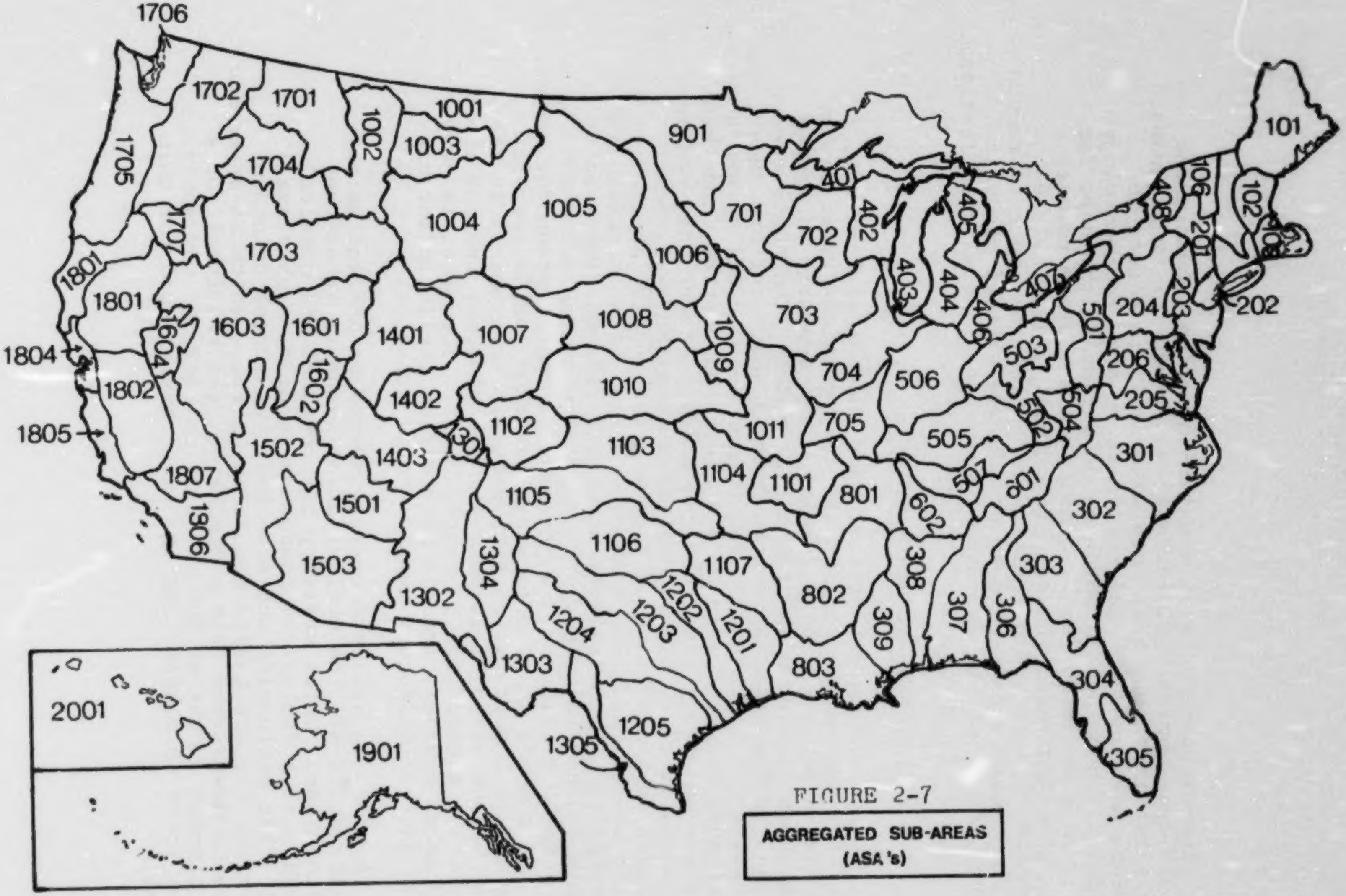
[1] Control technology includes the use of low-sulfur fuels.

Energy production is a water-intensive industry and future development will increase water use for two reasons. The first is simply that more water will be needed to produce more energy. The second is related to technology. Although technological advances have reduced the need for water in some cases (e.g., closed-cycle cooling towers), they have increased the need in others. That is, the emphasis of some energy-related technology has been to reduce environmental impacts and to devise new ways of producing energy, often at the expense of water (e.g., coal gasification).

2.4.2. General Model Description

In connection with the Project Independence effort, a model has been developed for EPA that predicts water-use by Aggregated Sub-Area (ASA) for any given scenario of energy development generated by FEA's PIES model. The ASA's are defined by the Water Resources Council (WRC) and are shown in Figure 2-7. The ASA's were chosen because all of WRC's water supply and water use data are based on them, and these data are necessary inputs to the model. "Water-use" consists of two major categories. The first is withdrawal, which includes any water removed from a water supply, whether or not it is returned; the second, a subset of withdrawal, is consumption, which includes any water removed from a water supply and not returned. The objective of the Water-Use Model is to predict both withdrawal and consumption for each ASA and compare it to both annual average and 20-year low flow supply. What varies from scenario to scenario in the model is the energy-related water demands computed for the activities treated in the Supply Model. The model is very adaptable, however, and can be modified easily to include other uses or different supply characteristics.

A model to indicate energy impacts on ambient water quality would aid the evaluation of scenario water use implications. Unfortunately, the physical and chemical dynamics of hydrological phenomena occur on such a small scale that nationwide and even basin-wide predictions of water quality are hardly possible. A river which is anaerobic 30 yards downstream from a discharger can rid itself of a significant amount of BOD in 30 miles, defying any analysis which looks no closer than the river basins used for this model.


1706
1702
1701
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1003
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1705
1704
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1007
1008
1009
703
406
503
501
206
1804
1604
1602
1402
1010
704
506
504
205
1802
1102
1011
705
505
502
1805
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1301
1103
1104
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801
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601
301
1807
1501
1105
602
302
1306
1106
1107
308
303
1503
1304
1302
1202
802
307
306
1204
1203
1201
309
2001
1303
803
304
1901
1205
1305
305

FIGURE 2-7

AGGREGATED SUB-AREAS (ASA's)

2.4.3 Detailed Model Description

Essentially, the model is a modification of work performed by WRC to allow energy demands on water to be a variable input. There are two sections to the model. The first section takes as input the energy activity levels and from these computes energy-associated water withdrawal and consumption for each ASA. The second section assesses the resulting energy use of water in relation to the amount of water available for energy (i.e., total water supply minus non-energy use).

2.4.3.1 Water Required for Energy

Before the Water-Use Model can be run, the Supply Model must be run to generate the levels of energy activity by river basin for a scenario. (See Figure 2-2 for a map of river basins and Table B-1 for the index.) An important consideration for water use is the level of activity associated with the uranium fuel cycle other than power generation. These levels were not disaggregated to river basins in the Supply Model. Therefore, the levels of activity of each phase of the uranium fuel cycle (except for nuclear power generation) by river basin are determined here. Levels of mining and milling are allocated to river basins according to the distribution forecast by the Energy Research and Development Administration (ERDA). Levels of enrichment, fabrication and reprocessing activities are allocated to river basins according to proposed capacities of existing facilities. Data for this were obtained from ERDA and several Atomic Energy Commission (AEC) reports. One other adjustment was necessary. Levels of refinery activity are separated into the contribution from projected and existing refineries because of the significant increase in the water efficiency of proposed units.

Coefficients have been developed[1] for water withdrawal and water consumption per fuel unit of energy activity, e.g. the number of gallons of water withdrawn and consumed per ton of coal mined or per barrel of oil burned to generate electricity. These coefficients vary from region to region of the country to reflect differences of applied technologies and efficiencies. Multiplying the coefficients by the appropriate activities and summing the results over activities gives total withdrawal and consumptive use of water by river basin. Since the data for the supply of water (obtained from WRC) are given by ASA, water use by river basin is aggregated to ASA. So,

---

[1] Hittman Associates, Inc., Final Water Withdrawal and Consumption Coefficients for the Project Independence Energy Production Activities, for the U.S. Environmental Protection Agency, 1975.

$$W_h = \sum_{i\varepsilon h} \sum_{k} A_{ik} . U_{ik} \qquad (2\text{-}17)$$

$$C_h = \sum_{i\varepsilon h} \sum_{k} A_{ik} . V_{ik}, \qquad (2\text{-}18)$$

where W_h and C_h are the withdrawal and consumption, respectively, in ASA h,

A_{ik} is the level of activity k in river basin i, and

U_{ik} and V_{ik} are the withdrawal and consumption coefficients, respectively, for activity k in river basin i.

2.4.3.2 Water Available for Energy

Total water availability in an ASA is the sum of inflows from upstream ASA's, imports from other ASA's, groundwater supply and indigenous supply (natural runoff) minus exports to other ASA's. Though indigenous supply data is not explicitly available, exit flow is, so indigenous supply may be calculated. WRC has supplied this data as well as data on water withdrawal and consumption for each ASA by 2-digit SIC.

In order to make energy water demand a variable input defined by each scenario, it is necessary to reconstruct the WRC data base as described below. WRC has predicted energy-associated water use for a particular case of projected development. Changing predictions of energy-associated demand only changes water use of selected SIC's and, therefore, exit flows. (Since exit flows are inflows for downstream ASA's, these inflows, too, are changed. Because of this effect all calculations must be made in successive downstream order of ASA's, starting with ASA's that have no inflows.) Then water available for energy is simply the sum of WRC-predicted exit flow, WRC-predicted consumption of water for energy purposes and the difference between the model-generated upstream inflows and the WRC-predicted inflows. That is, water available for energy in ASA h is defined by

$$H_h = E_h' + (I_h - I_h') + C_h' , \qquad (2\text{-}19)$$

where C_h' is WRC-predicted consumption of water due to energy in ASA h,

I_h' is WRC-predicted inflow in ASA h,

E_h' is WRC-predicted exit flow in ASA h, and

I_h is the model-generated inflow in ASA h, i.e., the model exit flows of upstream ASA's.

2.4.3.3 Comparison of Water Supply and Demand

The model exit flow is $E_h = H_h - C_h$. Clearly, a problem exists if E_h is less than zero. That is, more water is consumed than is available. E_h may be greater than zero for average annual flow, but less than zero for the 20-year low flow case.

W_h/H_h is the ratio of water withdrawn for energy to water available for energy. This may be greater than one without straining water supply since any water parcel may be withdrawn over and over as it travels the course of a river. However, a number substantially larger than one indicates an ASA that may be water constrained, depending on site-specific demand-supply characteristics.

2.5 Air Quality Model

2.5.1 Introduction

Although comparison of air pollution loadings among scenarios provides a useful means for evaluating major environmental impacts on a geographical basis, the comparison of the effects these loadings will have on ambient air quality is much more meaningful to decision makers. Unlike hydrological phenomena, atmospheric mixing occurs on a large enough scale to enable rough estimates of the general air quality in most AQCR's. In order to accomplish such an analysis, the Air Quality Model relates 1972 air quality to emissions and then applies this relationship to the emissions predicted for a given scenario. Using such a process, comparisons may be made among scenarios of their relative impacts on regional air quality. However, the approach is experimental, being severely limited by data availability, and has yet to be used as the basis for any policy decisions.

The crucial assumption in the Air Quality Model is that the relationship between emissions and ambient quality is linear and time independent in every AQCR. This is justifiable only insofar as no drastic changes occur in the distribution or overall quantity of particulates and SO_x emitted between 1972 and 1985. It also requires that each AQCR experience no drastic climatological changes during the interim. Moreover, because the analysis is conducted on an AQCR-wide scale, no distinction is made between point and area sources of residuals or between stack heights at which pollutants are emitted. Site-specific air quality models cannot be applied in this context because projections of the location of energy activities cannot be accurate beyond the AQCR level. At this point in time, attempts at formulating a more precise functional relationship between emissions and quality are also hampered by the fact that monitoring of emissions and air quality only now approaches a comprehensive network. Until a substantial history of comprehensive monitoring in all AQCR's becomes available, roll-back approximations like that used in the Air Quality Model will be the best empirical relationships obtainable for this level of analysis. For this reason, it is imperative that the output of the model be used for comparison purposes only. The air quality estimates do not necessarily provide realistic predictions of 1985 air quality.

However, since the same analysis is used regardless of the scenario being considered, the model is useful as a basis for comparison among scenario impacts on air quality.

2.5.2 General Model Description

Input to the Air Quality Model consists of energy-associated emissions generated in AQCR's by the Residual Allocation Model for particulates and SO_x. (The lack of adequate monitoring data to evaluate 1972 air quality for other pollutants precluded their consideration.) The model converts the emissions for a single AQCR to an air quality value and range using conversion factors based on the ratio of measures of 1972 quality to 1972 emissions data. The measures of 1972 air quality are generally the minimum, median, and maximum of the 1972 average annual concentrations for all monitoring stations in each AQCR. However, since not all AQCR's were monitored for both pollutants in 1972, some of the data used in the present model are taken from 1974 data, or, in some cases, from data for AQCR's judged to possess similar topographic, atmospheric, demographic, and industrial characteristics.

2.5.3 Detailed Model Description

2.5.3.1 1972 Air Quality

Air quality monitoring data for 1972 and 1974 was obtained from the National Air Data Branch (NADB) of EPA for both of the pollutants. Each monitoring station was assigned to the appropriate AQCR. Then the minimum, median and maximum of the 1972 annual averages of all monitoring stations in each AQCR were taken as measures of 1972 air quality in that AQCR. Not all AQCR's had monitoring stations with annual averages for both pollutants in 1972. For this reason, a priority scheme was devised to obtain "1972 air quality" for all AQCR's, including those for which no monitoring data are available. For each AQCR minimum, median and maximum values were taken from the first of the following sets for which data were available:

1. 1972 annual averages;
2. 1974 annual averages;

3. 1972 50th percentiles for particulates, 70th percentiles for sulfur oxides;
4. 1974 50th percentiles for particulates, 70th percentiles for sulfur oxides; and
5. Air quality of a similar AQCR.

In the NADB data, geometric means are used for particulates concentrations and arithmetic means are used for sulfur oxides. Empirically, the frequency distributions for the concentrations of both pollutants are nearly lognormal, so that the geometric means are closely approximated by the medians. The arithmetic means, on the other hand, lie almost two deciles to the right of the median of a lognormal distribution. Therefore, 50th percentiles are taken as the average annual particulate concentrations, and 70th percentiles are used to represent average annual sulfur oxide values. The theory underlying this discussion is treated briefly in Appendix C.

2.5.3.2 Air Quality from Emissions

A factor f_{ij} is obtained for pollutant j in AQCR i by dividing "1972 air quality" (i.e., the value of one of the measures discussed in Section 2.5.3.1) by 1972 total emissions:

$$f_{ij} = Q_{ij}(1972) \; / \; E_{ij}(1972) \qquad (2\text{-}19)$$

Predicted air quality for scenario x is then determined using the emissions generated by the Supply and End-Use Models and multiplying by f_{ij}:

$$Q_{ij}(x) = f_{ij} \cdot E_{ij}(x) \qquad (2\text{-}20)$$

where E_{ij} is the energy-associated emission of pollutant j in AQCR i. This predicted quality is useful only for comparative purposes and should not be construed as the absolute predicted air quality.

2.6 Error Analysis

2.6.1 Underlying Assumptions of Models

The assumptions for the Residual Allocation Models (Supply and End-Use) relate primarily to distribution techniques and boundary approximations and are summarized in Table 2-1. The accuracy of the Water-Use Model depends on the reliability of the distribution of energy activities as determined by the Supply Model, the water-use coefficients and the WRC water supply and use data. The accuracy of the Air Quality Model depends on the reliability of the distribution of emissions predicted by the Supply and End-Use Models, the relationships between emissions and air quality and the air quality data for 1972 and 1974 obtained from NADB.

Since levels of activity and pollution loadings are allocated to river basins or AQCR's, a misallocation will not significantly affect Demand Region loadings and will not affect national loadings at all (aggregation of misallocated loadings tends to reduce the amount of error). If levels of activity alone had been allocated and then multiplied by the regional residual coefficients, any misallocation might have implied application of the wrong coefficient so that Demand Region and National aggregations would also be in error.

2.6.2 Residual Allocation Model

Both the Supply and End-Use Models allocate regional levels of activity to river basins (AQCR's):

$$L_{jkm} = A_{ikm} \cdot F_{ijm} \qquad (2\text{-}2)$$

where L_{jkm} is the amount of residual k caused by activity m in river basin (AQCR) j,

A_{ikm} is the amount of residual k caused by activity m in FEA Region i,

F_{ijm} is the fraction of activity m in FEA Region i allocated to river basin (AQCR) j.

So, the total amount of residual k in river basin (AQCR) j is:

$$R_{jk} = \sum_m L_{jkm} \qquad (2\text{-}3)$$

Errors in the model are then attributable only to errors in distribution and geographic definition, i.e., to errors in F_{ijm}. Error in R_{jk} due to any one activity is:

$$\Delta R_{jk} = \Delta L_{jks} = A_{iks}\ (\Delta F_{ijs}) \qquad (2\text{-}21)$$

and sensitivity is

$$\frac{\Delta R_{jk}}{R_{jk}} = \frac{A_{iks}\ (\Delta F_{ijs})}{\sum_m A_{ikm}\ F_{ikm}}\ . \qquad (2\text{-}22)$$

To evaluate this sensitivity a ΔF_{ijs} of 10 percent was considered, one at a time for all i, j and s for 1972. Tables 2-5 through 2-9 show the number of river basins grouped in ranges of sensitivity relative to a 10 percent misallocation of each activity for each residual. For example, the 61 in Table 2-5 for the TRN GAS row and PART column means total particulate emissions in 61 river basins would be off between 0 and 2 percent if a 10 percent misallocation of gasoline-fueled transportation activity were to occur in each river basin. The tables indicate that a 10 percent misallocation of any activity generally would cause less than a 2 percent error of the total of any residual. Exceptions exist when a particular activity dominates the contribution of a residual to a river basin. Principal exceptions are:

1. Particulates and SO_x from industrial coal use;
2. Air pollutants from gasoline-fueled transportation, especially hydrocarbons, carbon monoxide and aldehydes;
3. Hydrocarbons from natural gas production;
4. Organics from oil production;

TABLE 2-5

NUMBER OF RIVER BASINS SENSITIVE TO 10% MISALLOCATION OF ACTIVITY, GROUPED IN RANGES OF TOTAL RESIDUAL ERROR

1972 SCENARIO

$>0\%$ AND $\leq 2\%$

	RESIDUALS												
ACTIVITIES	BASES	TDS	SS	ORGANICS	THERMAL	PART	NO(X)	SO(X)	HC	CO	ALDEHYDE	SOLIDS	FIX LAND	INC LAND
IND COAL	0	0	0	0	0	104	214	162	217	217	0	0	0	0
IND NATGAS	0	0	0	0	0	235	234	235	235	235	0	0	0	0
IND DSTOIL	0	0	0	0	0	235	235	235	235	235	235	0	0	0
IND RESOIL	0	0	0	0	0	231	233	217	235	235	235	0	0	0
TRN GAS	0	0	0	0	0	61	37	281	35	0	4	0	0	0
TRN JET F	0	0	0	0	0	214	214	214	214	214	214	0	0	0
TRN DSTOIL	0	0	0	0	0	243	130	226	306	312	287	0	0	0
TRN RESOIL	0	0	0	0	0	86	87	82	88	88	0	0	0	0
R-C NATGAS	0	0	0	0	0	324	324	324	324	324	0	0	0	0
R-C DSTOIL	0	0	0	0	0	302	324	272	324	324	324	0	0	0
R-C RESOIL	0	0	0	0	0	320	324	302	324	324	324	0	0	0
NATGAS PRD	0	0	0	0	0	106	106	109	48	109	106	0	106	0
OIL PROD	0	0	0	5	0	0	0	0	0	0	0	0	92	0
HI BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LO BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL LQFCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OIL SHALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL FR PP	0	49	41	32	24	73	32	11	105	105	105	19	80	0
OIL FR PP	0	29	24	33	24	42	36	23	49	50	45	0	30	0
GAS FR PP	0	76	76	91	40	111	38	112	112	112	0	0	99	0
TURBINES	0	6	0	7	0	6	6	7	0	0	0	0	7	0
NUCLEAR PP	0	4	0	11	0	0	0	0	0	0	0	0	19	0
HYDROELECT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REFINERIES	0	33	14	52	41	74	90	34	59	93	67	58	69	0
OLD U COAL	1	16	26	0	0	46	46	46	46	46	0	35	47	1
OLD S COAL	12	27	23	0	0	76	82	82	82	82	82	19	72	33
NEW U COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEW S COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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TABLE 2-6

NUMBER OF RIVER BASINS SENSITIVE TO 10% MISALLOCATION OF ACTIVITY, GROUPED IN RANGES OF TOTAL RESIDUAL ERROR

1972 SCENARIO

>2% AND ≤ 4%

	RESIDUALS													
ACTIVITIES	BASES	TDS	SS	ORGANICS	THERMAL	PART	NO(X)	SO(X)	HC	CO	ALDEHYDE	SOLIDS	FIX LAND	INC LAND
IND COAL	0	0	0	0	0	49	3	27	0	0	0	0	0	0
IND NATGAS	0	0	0	0	0	0	1	0	0	0	0	0	0	0
IND DSTOIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IND RESOIL	0	0	0	0	0	3	2	11	0	0	0	0	0	0
TRN GAS	0	0	0	0	0	98	78	41	24	0	13	0	0	0
TRN JET F	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRN DSTOIL	0	0	0	0	0	54	95	36	9	4	22	0	0	0
TRN RESOIL	0	0	0	0	0	1	1	5	0	0	0	0	0	0
R-C NATGAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-C DSTOIL	0	0	0	0	0	22	0	34	0	0	0	0	0	0
R-C RESOIL	0	0	0	0	0	4	0	13	0	0	0	0	0	0
NATGAS PRD	0	0	0	0	0	2	1	0	16	0	2	0	4	0
OIL PROD	0	0	0	11	0	0	0	0	0	0	0	0	4	0
HI BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LO BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL LQFCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OIL SHALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL FR PP	0	5	14	13	6	16	31	9	0	0	0	6	5	0
OIL FR PP	0	3	4	1	2	7	7	8	0	0	3	0	2	0
GAS FR PP	0	6	5	3	13	1	19	0	0	0	0	0	3	0
TURBINES	0	0	0	0	0	1	1	0	0	0	0	0	0	0
NUCLEAR PP	0	3	0	2	0	0	0	0	0	0	0	0	0	0
HYDROELECT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REFINERIES	0	10	11	9	18	13	10	17	24	9	18	2	5	0
OLD U COAL	5	4	7	0	0	0	0	0	0	0	0	6	2	0
OLD S COAL	7	1	1	0	0	4	0	0	0	0	0	15	5	13
NEW U COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEW S COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2-7

NUMBER OF RIVER BASINS SENSITIVE TO 10% MISALLOCATION OF ACTIVITY, GROUPED IN RANGES OF TOTAL RESIDUAL ERROR 1972 SCENARIO

>4% AND ≤ 6%

	RESIDUALS													
ACTIVITIES	BASES	TDS	SS	ORGANICS	THERMAL	PART	NO(X)	SO(X)	HC	CO	ALDEHYDE	SOLIDS	FIX LAND	INC LAND
IND COAL	0	0	0	0	0	36	0	12	0	0	0	0	0	0
IND NATGAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IND DSTOIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IND RESOIL	0	0	0	0	0	1	0	5	0	0	0	0	0	0
TRN GAS	0	0	0	0	0	102	111	2	19	3	28	0	0	0
TRN JET F	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRN DSTOIL	0	0	0	0	0	12	28	33	1	1	5	0	0	0
TRN RESOIL	0	0	0	0	0	1	0	0	0	0	0	0	0	0
R-C NATGAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-C DSTOIL	0	0	0	0	0	0	0	1	0	0	0	0	0	0
R-C RESOIL	0	0	0	0	0	0	0	7	0	0	0	0	0	0
NATGAS PRD	0	0	0	0	0	1	1	0	10	0	1	0	1	0
OIL PROD	0	0	0	9	0	0	0	0	0	0	0	0	4	0
HI BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LO BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL LQFCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OIL SHALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL FR PP	0	9	8	8	[illegible]	6	22	14	0	0	0	7	6	0
OIL FR PP	0	3	2	2	6	0	5	7	1	0	1	0	2	0
GAS FR PP	0	3	2	2	11	0	3	0	0	0	0	0	2	0
TURBINES	0	1	0	0	0	0	0	0	0	0	0	0	0	0
NUCLEAR PP	0	1	0	1	0	0	0	0	0	0	0	0	1	0
HYDROELECT	0	0	0	0	0	0	0	0	0	0	0	0	1	0
REFINERIES	0	10	10	13	7	7	3	4	13	2	11	2	7	0
OLD U COAL	10	1	7	0	0	0	0	0	0	0	0	2	0	2
OLD S COAL	10	2	3	0	0	2	0	0	0	0	0	6	2	2
NEW U COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEW S COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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TABLE 2-8

NUMBER OF RIVER BASINS SENSITIVE TO 10% MISALLOCATION OF ACTIVITY, GROUPED IN RANGES OF TOTAL RESIDUAL ERROR

1972 SCENARIO

>6% AND ≤ 8%

	RESIDUALS												
ACTIVITIES	BASES	TDS	SS	ORGANICS	THERMAL	PART	NO(X)	SO(X)	HC	CO	ALDEHYDE	SOLIDS	FIX LAND	INC LAND
IND COAL	0	0	0	0	0	23	0	14	0	0	0	0	0	0
IND NATGAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IND DSTOIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IND RESOIL	0	0	0	0	0	0	0	2	0	0	0	0	0	0
TRN GAS	0	0	0	0	0	56	73	0	42	15	71	0	0	0
TRN JET F	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRN DSTOIL	0	0	0	0	0	7	11	18	1	0	2	0	0	0
TRN RESOIL	0	0	0	0	0	0	0	1	0	0	0	0	0	0
R-C NATGAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-C DSTOIL	0	0	0	0	0	0	0	17	0	0	0	0	0	0
R-C RESOIL	0	0	0	0	0	0	0	2	0	0	0	0	0	0
NATGAS PRD	0	0	0	0	0	0	1	0	17	0	0	0	0	0
OIL PROD	0	0	0	7	0	0	0	0	0	0	0	0	5	0
HI BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LO BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL LQFCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OIL SHALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL FR PP	0	9	11	12	17	7	12	27	0	0	0	7	2	0
OIL FR PP	0	2	4	2	4	0	1	8	0	0	0	0	1	0
GAS FR PP	0	0	1	0	10	0	2	0	0	0	0	0	0	0
TURBINES	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NUCLEAR PP	0	2	0	0	0	0	0	0	0	0	0	0	0	0
HYDROELECT	0	0	0	0	0	0	0	0	0	0	0	0	3	0
REFINERIES	0	6	13	5	6	5	1	12	6	0	6	2	4	0
OLD U COAL	7	8	1	0	0	0	0	0	0	0	0	4	3	13
OLD S COAL	5	2	1	0	0	0	0	0	0	0	0	8	0	0
NEW U COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEW S COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2-9

NUMBER OF RIVER BASINS SENSITIVE TO 10% MISALLOCATION OF ACTIVITY, GROUPED IN RANGES OF TOTAL RESIDUAL ERROR

1972 SCENARIO

>8% AND ≤ 10%

	RESIDUALS												
ACTIVITIES	BASES	TDS	SS	ORGANICS	THERMAL	PART	NO(X)	SO(X)	HC	CO	ALDEHYDE	SOLIDS	FIX LAND	INC LAND
IND COAL	0	0	0	0	0	5	0	2	0	0	0	0	0	0
IND NATGAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IND DSTOIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IND RESOIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRN GAS	0	0	0	0	0	7	23	0	204	306	208	0	0	0
TRN JET F	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRN DSTOIL	0	0	0	0	0	2	4	5	1	1	2	0	0	0
TRN RESOIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-C NATGAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-C DSTOIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-C RESOIL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NATGAS PRD	0	0	0	0	0	2	2	2	20	2	2	0	0	0
OIL PROD	0	0	0	78	0	0	0	0	0	0	0	0	5	0
HI BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LO BTU GAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL LQFCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OIL SHALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COAL FR PP	0	33	31	40	54	1	8	44	0	0	0	66	12	0
OIL FR PP	0	13	16	12	14	1	1	4	0	0	1	0	15	0
GAS FR PP	0	27	28	16	30	0	0	0	0	0	0	0	8	0
TURBINES	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NUCLEAR PP	0	11	0	7	21	0	0	0	0	0	0	0	1	0
HYDROELECT	0	0	0	0	0	0	0	0	0	0	0	0	176	0
REFINERIES	0	45	56	25	30	0	0	37	2	0	2	40	19	0
OLD U COAL	29	23	11	0	0	0	0	0	0	0	0	5	0	36
OLD S COAL	8	25	29	0	0	0	0	0	0	0	0	34	3	34
NEW U COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEW S COAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5. Water pollutants, SO_x and solids from coal-fired power plants and refineries;
6. Water pollutants from oil- and gas-fired power plants;
7. Total dissolved solids and thermal from nuclear power plants;
8. Fixed land from hydroelectric plants; and
9. Bases, total dissolved solids, suspended solids, solids and maximum incremental land from coal mining.

Note that since this test is based on a 1972 scenario, no synthetic fuels, oil shale or new coal mines are considered.

2.6.3 Water-Use Model

The Water-Use Model predicts withdrawal and consumption of energy-related activities by Aggregated Sub-Area (ASA) and compares them to water available for energy. The prediction of water available is based entirely on data obtained from WRC. Energy-related water use predictions are based on the projected distribution of energy activities (from the Supply and End-Use Models) and the water use coefficients:

$$W_h = \sum_{i \varepsilon h} \sum_k A_{ik} \cdot U_{ik} \qquad (2\text{-}17)$$

$$C_h = \sum_{i \varepsilon h} \sum_k A_{ik} \cdot V_{ik}, \qquad (2\text{-}18)$$

where W_j and C_j are the withdrawal and consumption, respectively, in ASA h,

A_{ik} is the level of activity k in river basin i, and

U_{ik} and V_{ik} are the water withdrawal and consumption coefficients, respectively, for activity k in river basin i.

Then error in W_h or C_h caused by error in any one A_{mn} is $(\Delta W_h) = (\Delta A_{mn})U_{mn}$, $(\Delta C_h) = (\Delta A_{mn})V_{mn}$. Sensitivity is:

$$\frac{\Delta W_h}{W_h} = \frac{(\Delta A_{mn})U_{mn}}{\sum\limits_{i\varepsilon h} \sum\limits_{k} A_{ik}U_{ik}} \quad , \quad \frac{\Delta C_h}{C_h} = \frac{(\Delta A_{mn})V_{mn}}{\sum\limits_{i\varepsilon h} \sum\limits_{k} A_{ik}V_{ik}} \; . \qquad (2\text{-}23 \;\&\; 2\text{-}24)$$

The type of error that is most likely to occur is a misallocation of the form:

> Too much of an activity allocated to a river basin and not enough to a neighboring one.

However, aggregation of river basins to ASA's tends to compensate for this type of error.

To evaluate the sensitivity of a misallocation to an ASA, a ΔA_{mn} of 10 percent was considered, one at a time for all m and n for 1972. Table 2-10 shows the number of ASA's grouped in ranges of sensitivity relative to a 10 percent misallocation of each activity for water withdrawal and consumption. For example, the 32 for the withdrawal row of the 0 to 2 percent section in the underground coal column means 32 ASA's would be off between 0 and 2 percent if a 10 percent misallocation of surface coal mining activity were to occur in each ASA. The table indicates that a 10 percent misallocation of any activity would generally cause less than a 2 percent error in the total water demand. The principal exceptions are refineries and coal-fired power plants which are the major users of water in several ASA's.

2.6.4 Air Quality Model

The final air quality predictions are of the form:

$$Q_{ij}(x) = f_{ij} \cdot E_{ij}(x), \qquad (2\text{-}20)$$

TABLE 2-10

NUMBER OF ASA'S SENSITIVE TO 10% MISALLOCATION OF ACTIVITY GROUPED IN RANGES OF TOTAL RESIDUAL ERROR 1972 SCENARIO

SENSITIVITY TO 10% CHANGE	UNDERGROUND COAL	SURFACE COAL	NATURAL GAS PRODUCTION	OIL	URANIUM EXTRACTION	URANIUM ENRICHMENT	URANIUM REPROCESSING	URANIUM FABRICATION	HI BTU GASIFICATION	LO BTU GASIFICATION	COAL LIQUEFACTION	OIL SHALE	REFINERIES	COAL-FIRED POWER PLANTS	OIL-FIRED POWER PLANTS	GAS-FIRED POWER PLANTS	NUCLEAR POWER PLANTS
>0 ≤ 2%																	
Withdrawal	32	45	45	49	7	3	0	5	0	0	0	0	37	18	24	38	16
Consumption	33	45	43	48	7	3	0	0	0	0	0	0	10	22	28	56	14
>2 ≤ 4%																	
Withdrawal	1	0	2	1	0	0	0	0	0	0	0	0	11	8	2	8	2
Consumption	0	0	4	2	0	0	0	0	0	0	0	0	5	13	2	4	3
>4 ≤ 6%																	
Withdrawal	0	0	0	0	0	0	0	0	0	0	0	0	7	7	3	7	1
Consumption	0	0	3	1	0	0	0	0	0	0	0	0	10	11	1	8	1
>6 ≤ 8%																	
Withdrawal	0	0	0	0	0	0	0	0	0	0	0	0	3	11	3	9	0
Consumption	0	0	0	0	0	0	0	0	0	0	0	0	18	5	5	1	1
>8 ≤ 10%																	
Withdrawal	0	1	0	0	1	0	0	0	0	0	0	0	18	21	8	3	7
Consumption	0	1	0	0	1	0	0	0	0	0	0	0	25	8	4	3	2

where $Q_{ij}(x)$ is the air quality of scenario x in AQCR i for pollutant j,

$E_{ij}(x)$ are the emissions of pollutant j for scenario x in AQCR i, and

$$f_{ij} = Q_{ij}(1972) / E_{ij}(1972) \qquad (2\text{-}19)$$

Clearly, model error is directly proportional to f_{ij} and $E_{ij}(x)$. Error in $E_{ij}(x)$ was discussed in Section 2.6.2. Error in f_{ij} is directly proportional to error in $Q_{ij}(1972)$ (i.e., error in the monitoring data and interpretations) and inversely proportional to error in $E_{ij}(1972)$.

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CHAPTER THREE

TECHNIQUES FOR COMPARISON AND PRESENTATION

3.1 The Problem

After scenarios have been processed, it is necessary to analyze and present for comparison the results of the models in a meaningful and readable way. There are 335 river basins or 243 AQCR's, each containing as many as 26 activities generating 15 residuals in the Residual Allocation Model. There are 101 ASA's each characterized by several statistics representing mean and low flow cases of withdrawal and consumption data for energy and non-energy use in the Water-Use Model. There are 243 AQCR's, each with forecasts of two parameters (particulates and SO_x) measured in three different ways (minimum, median and maximum) in the Air Quality Model. This represents well over 100,000 pieces of data for each scenario.

The River Basin and AQCR values are useful in that they represent the finest degree of detail achievable by the model, and impacts on those size regions, at least, should be evaluated to determine areas that incur a disproportionate amount of environmental impact. However, it appears impossible to grasp the implications on an overall basis at that level. Thus, a tradeoff exists between the level of detail involved in the analysis and comprehensibility of the results. Objective analysis can be done on the large data bases by computer, but the problem of presenting the results almost necessarily requires aggregate or summary statistics. Many techniques were considered. The advantages and disadvantages of some of these are discussed below. For the most part they involve aggregating the data in some form to the 10 Demand Regions. Even at this level the sheer number of data points made scenario comparisons a tedious task, so national summaries were also presented for the general public.

3.2 Attempts at Solution

3.2.1 Single Index

The use of a measure which would aggregate all the individual residuals into a single index was considered and rejected. Although it would have provided a simple means of ranking the scenarios, it would have involved the use of weighting factors to be applied to the residuals. The state of the art has not advanced to the point where objective weighting factors are available, and judgmental ones would have introduced a subjective factor into the analysis. Moreover, it was felt that as much information as possible should be presented concerning the environmental impacts, and thus it was better to display the entire list of residuals, rather than a single number.

3.2.2 Overlays

An attempt was made to display the residuals as overlays on a national map. However, it proved confusing to present more than two pollutants at a time, or alternatively, to compare more than two scenarios at a time (Figure 5-2). Moreover, the river basins and AQCR's form too small a set of boundaries for good visual display.

3.2.3 Tabular Presentation

One successful approach to presenting residuals on a regional basis was in the form of tables. In order to make the data manageable, the residuals from the river basins were aggregated into the 10 Demand Regions. An example of this format is presented in Table 6-4. Here the method of comparison is simply to match the quantities of a particular residual from one scenario to another at the Demand Region level.

3.2.4 Graphical

The regional tabular method is the most straightforward. However, it tends to take up a lot of space, and major differences are difficult to extract from the details. Consequently, presentation of the residuals on a national basis in the form of bar charts was also done. This is illustrated in Figure 6-2. Although simplifying the presentation, this approach has the effect of discarding the information on regional impacts, which is one of the major objectives of the PIES approach. Regional bar charts were made as well (Figures A-1 to A-10). Here scenario comparison within each region is improved, but at the expense of overall comprehensibility.

3.2.5 Differential Comparison

As a way of recovering some of the difficulties of the regional tabular approach, a matrix was prepared showing qualitatively the differences in residuals between two selected scenarios, one dimension of the matrix being regions, the other dimension being the individual residuals. The matrix is presented in Table 4-8. While it does provide a concise detailed comparison, the method's disadvantages are that it cannot be extended in a simple manner to comparison of three or more alternatives, and quantitative differences are lost altogether.

3.2.6 National Ranking of Scenarios by Residual

By ranking the scenarios according to their relative contribution of the different residuals (Table 7-4) a preferential ordering may be possible. This will be the case if the scenarios are fairly consistent for the residuals of concern. Limiting the number of residuals enhances the probability of a choice. However, this is only a comparison at the national level and the probability of obtaining a clear ordering is small.

3.2.7 Water-Use Comparison

The purpose of the Water-Use Model is to identify areas that may have difficulty supplying the water required for energy development. To present this information a matrix was prepared indicating the ASA's with critical water supply for each scenario (Table 7-6). The format is easy to read, but to compare scenarios some interpretation of the relative importance of water shortages in each ASA is still necessary. (Some ASA statistics are presented in the table to aid this interpretation.) Furthermore, the definition of critical water supply in various ASA's may be somewhat arbitrary. In this case consumption exceeding the 20-year low flow supply condition was assumed to be critical, but exceeding the mean supply levels is certainly cause for concern.

3.2.8 Air Quality Comparison

To summarize the air quality data, tables were prepared to compare for each Demand Region the population-weighted air quality of each scenario (Tables 7-7 and 7-8). Scenario comparison within each region is easy, but overall comparison is still difficult. There is also some question of the significance of the measure. That is, the concept of a characteristic air quality in an AQCR is dubious at best. There are a variety of techniques that may be applied, but none are supported by sufficient data and none are universally appealing. For instance, should the measure represent average air quality or a worst case?

3.3 Conclusions on Display Techniques

Every approach reflects different compromises to the unavoidable tradeoffs among level of detail, overall comprehensibility, and significance of the results. Some methods are visual, some require interpretation. Some are national aggregations, some are regional. The question of significance raises further issues, however. It is important to remember that the purpose of these formats is to aid scenario comparison. Various types of impacts are assessed. To compare scenarios the relative importance of these different impacts is a vital issue. Some regions may be more sensitive to loadings than others in many respects, and a serious problem remains as to the different relative importance of various pollutants within each region. Furthermore, for each type of impact critical levels need to be established. It may be more important to know that no scenario exeeds some critical value than to know that one scenario has a higher value than another. An attempt has been made to keep the forms used here as objective as possible, but simplification and aggregation have implied the use of weighting factors (e.g., population in the case of air quality). If no explicit weighting factor is applied then the implicit assumption is that all items being aggregated have equal value (e.g., when river basin loadings are aggregated to Demand Regions). If each of these value questions could be answered then each scenario could be characterized by one number. The Air Quality Index is 17 today!

PART II

SCENARIO ANALYSIS

INTRODUCTION TO PART II

Chapters Four through Seven contain the four sets of scenarios that have been analyzed:

Chapter Four - Project Independence Report, November 1974.

Chapter Five - Mandatory Oil Import Program, January 1975.

Chapter Six - Energy Independence Act, March 1975.

Chapter Seven - National Energy Outlook, 1976.

These analyses are presented for historical purposes. Each chapter renders the previous one obsolete.

Only the supply model was operational for the first three sets so the analyses focused on that aspect. Furthermore, because of the summary requirements of the reports involved, the level of analysis was restricted to Demand Region and National Impacts. Data for these analyses were taken from the FEA Environment Report and the FEA PIES Model Report for each scenario. These are computer outputs generated by FEA.

A much more detailed analysis was performed on the set of scenarios for the Project Independence Report[1] than for the other three sets of scenarios. This first set of scenarios received more attention because it was used to determine which forms of output were best suited for analysis and presentation. The most significant difference in the levels of detail of the reports is reflected in the regional assessments. A thorough analysis of regional impacts was performed for the Project Independence Report[2] (See Appendix A). The other differences are a more systematic scenario comparison (Section 4.4), a study on the importance of control technology (Section 4.5) and an evaluation of the threat of energy development to rare and endangered species (Section 4.6).

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[1] U.S. Environmental Protection Agency, Project Independence Blueprint: Environmental Quality Analysis Final Report Phase I, submitted by Energy Resources Co. Inc., Contract No: 68012845, December 1974.

[2] U.S. Environmental Protection Agency, Project Independence Report Phase I, submitted by Energy Resources Co. Inc., December 1974.

Following is a brief outline and description of the general analytical technique employed for each set of scenarios.

Major Energy Features

The environmental effects of the scenarios are dependent upon the predicted energy activities. Therefore, a detailed analysis is performed on the production levels for 1972 and for each 1985 scenario. The purpose of this production analysis is to insure the accuracy of the FEA computer output (several small errors were found and corrected) and to identify the specific energy activities causing pollution loadings in each region.

For instance, for the first three sets all FEA scenarios predicted a large increase over 1972 totals of surface coal production in FEA Coal Supply Region 7 (California, Oregon, Washington and Alaska). FEA and EPA analysts determined that this prediction was due to an error in the model; the increased production should have been distributed among the other Coal Supply Regions. Thus, the production and resulting pollution loadings were adjusted so that surface coal production in Coal Supply Region 7 remained at 1972 levels in all scenarios, while surface coal production was appropriately increased in the other Coal Supply Regions. This adjustment caused a decrease in surface coal mining loadings in Demand Regions 9 and 10, and corresponding increases in the other Demand Regions.

Another result of the analysis showed that in all the FEA scenarios in the first three sets, hydroelectric capacity was predicted to be 195,000 megawatts in 1985. For the last set this prediction was lowered to 187,000 megawatts. According to the The 1970 National Power Survey[1] by the Federal Power Commission, "total conventional hydroelectric power potential of the 48 contiguous states at both developed and undeveloped sites that have been inventoried is estimated to be about 146,000 megawatts of capacity." Total conventional hydroelectric power potential for all states is listed as 178,608 megawatts in Hydroelectric Power Resources of the United States by the Federal Power Commission, January 1, 1972.[1] The excess predicted by the FEA model over both estimates of potential conventional hydroelectric power generation seems to imply the development of large amounts of pumped storage capacity in all 1985 scenarios. Because of the significant differences between pumped storage and conventional hydroelectric power generation, separate reports for each of the two energy sources might be beneficial to the analysis.

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[1] Federal Power Commission, The 1970 National Power Survey, (Washington, D.C.: Government Printing Office, 1970), Vol. I, p. I-7-21.

Environmental Analysis

1. National Analysis

The national analysis section presents the results of analysis at the first level of comparison -- predicted total pollution loadings for the entire nation. This level of aggregation precludes analysis of the environmental impacts of the pollutants, since the impacts depend on the location, concentration and release per unit time of the pollutants. Comparisons of the amounts of residuals for each scenario including 1972, and the major contributing activities are presented.

2. Regional Analysis

The regional analysis section presents the results of analysis at the Demand Region level. Again certain environmental impacts are masked by this level of aggregation. Except for the Project Independence Report[2] (Appendix A) this analysis is kept brief and more qualitative in nature, but major regional differences and contributing activities are indicated.

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[1] Federal Power Commission, Hydroelectric Power Resources of the United States: Developed and Undeveloped, (Washington, D.C.: Government Printing Office, 1972), Table IV, p. xi.

[2] U.S. Environmental Protection Agency, Project Independence Report Phase I, submitted by Energy Resources Co. Inc., December 1974.

3. Effects on Water Supply (Chapter 7 only)

This is an analysis of the water available, compared to the water required, to support energy activities. This analysis was performed only on the final set of scenarios because the model had not been developed previously.

4a. Effects on Ambient Air Quality (Chapters 4 through 6)

In order to develop a crude indicator of where ambient air quality could violate standards due to energy development, maps were prepared for each scenario showing areas of the nation where ambient concentrations of SO(X) and/or particulates violated primary air quality standards in 1972 and where increased energy-associated loadings of the same pollutant are predicted for 1985. This does not necessarily mean that standards will be violated in these areas in 1985, since non-energy sources may be controlled and energy sources may be sited so as to minimize impacts on ambient quality. The maps do not indicate areas that met standards in 1972, but where large increases in energy activity may cause standards to be violated in 1985. Nor does it include areas that violated standards in 1972 by more than the reduction caused by lower energy contributions in 1985.

4b. Effects on Ambient Air Quality (Chapter 7 only)

The model for this analysis was only developed in time for the final set of scenarios. For each scenario, indications of relative 1985 air quality for particulates and SO(X) by AQCR are given. The results may be interpreted by (1) for any one scenario, comparisons of air quality for different AQCR's may be made, and (2) for any one AQCR, comparisons of the impact of different scenarios may be made. No absolute significance should be associated with these air quality numbers.

5. Uranium Fuel Cycle and Radiation

The analyses in the other sections do not include pollutants resulting from the uranium fuel cycle, except those from nuclear power plants -- nor are predicted radiation loadings included. Those loadings are presented separately as the last section of each analysis.

Since the predicted radiation from the uranium fuel cycle assumes compliance with standards, some environmental concerns are not indicated by the tables. These concerns involve nuclear accidents, possible radiation from fossil fuel use and the storage of radioactive wastes from nuclear power plants. These topics have been considered by recent AEC and EPA studies, thus they are not considered here.

CHAPTER FOUR

PROJECT INDEPENDENCE REPORT

4.1 Description of Scenarios

FEA developed the following strategies for the Project Independence Report:

- Business as Usual (BAU)
- Accelerated Supply (AS)
- Business as Usual with Conservation
- Demand Management

However, no Business as Usual with Conservation or Demand Management scenarios were provided for analysis. Business as Usual was defined to be a case in which existing policies continue and only limited new actions are considered. The Accelerated Supply Strategy is one in which the Federal Government takes a number of key actions to increase the domestic supply of energy. The principal actions are:

- Greatly accelerating Federal leasing of Outer Continental Shelf;
- Opening the Naval Petroleum Reserves to commercial exploration and development; and
- Removing some regulatory delays in nuclear power development.

Although several assumed prices of imported oil were considered, the analysis focused on $7 and $11 per barrel. FEA provided Environment Reports and PIES Model Reports of the following scenarios for analysis. This analysis was included in the final Project Independence[1] report of November 1974:

- Business as Usual -- $11 for imported oil (BAU/$11) (FEA #85 BAUIA-D7 OCT3-11MOD6)
- Business as Usual -- $7 for imported oil (BAU/$7) (FEA #85 BAUIA-D7 OCT3-7MOD6)

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[1] Federal Energy Administration, Project Independence (Washington, D.C.: Government Printing Office, November 1974).

- Accelerated Supply -- $11 for imported oil (AS/$11) (FEA #85 ACCIA-D7 OCT3-11MOD6)

- Accelerated Supply -- $7 for imported oil (AS/$7) (FEA #85 ACCIA-D7 OCT3-7MOD6)

In order to consider energy development through time, a 1972 "scenario" was developed utilizing assumptions and techniques comparable to those used for the 1985 scenarios with a data base of 1972 levels of activity.

4.2 Major Energy Features

Table 4-1 shows national production by activity in 1972 under each scenario.

Two approaches were taken to further compare the energy features of the scenarios. First, 1985 production at both the national level and at the supply region level, as predicted by the scenarios, was compared to corresponding 1972 levels. These results are presented in Table 4-2. Secondly, for a given strategy (BAU or AS) the two prices ($7 and $11) were compared. The results are summarized in Table 4-3. Differences in national production levels between prices for each activity are presented along with the energy supply regions that contribute most to the national change. Maps of the different regions are in Chapter One.

The major aspects of all scenarios compared to 1972 production levels include:

- Texas, Louisiana and the Rocky Mountains (not including the Northern Great Plains) show large increases in surface coal mining;

- Commercial scale production of shale oil is predicted;

- Virgin OCS areas are developed. Accelerated Supply scenarios include development of Naval Petroleum Reserve 4 in northern Alaska;

- Natural gas production and natural gas-fired power generation decline from 1972 levels;

- The Southeast shows very large refining increases;

TABLE 4-1

NATIONAL ENERGY PRODUCTION UNDER DIFFERENT FEA SCENARIOS

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	UNITS[a]
Surface Coal	753.887	1626.09	2116.35	1689.99	1965.54	(E3 tons/day)
Underground Coal	876.791	630.6671	1250.0402	701.954	994.8611	(E3 tons/day)
Natural Gas	72208.1	50847.5	50872.7	55990.	55990.	(E6 Scf/day)
Oil	9224.29	8878.12	12473.	12171.	14194.1	(E3 bbls/day)
Hi Btu Gasification	0	0	0	324.8	464	(E6 Scf/day)
Coal Liquefaction	0	0	0	56	80	(E3 bbls/day)
Lo Btu Gasification	0	0	0	0	0	(E6 Scf/day)
Oil Shale	0	250	250	1000	1000	(E3 bbls/day)
Power Plants						
Coal-Fired	914.485	1365.62	2265.83	1432.88	1872.94	(E3 tons/day)
Oil-Fired	1204.07	2975.87	1723.41	3371.58	1729.99	(E3 bbls/day)
Gas-Fired	9354.12	7107.01	4864.4	7020.05	6011.26	(E6 Scf/day)
Turbines	0	0	0	0	0	(E3 bbls/day)
Nuclear	0.3433	0.598	0.598	0.7	0.7	(tons U-235/day)
Hydroelectric	77.3212	195.094	195.094	195.094	195.094	(E3 MW)
Refineries	13853	17114.5	16332.2	17803.	16338.8	(E3 bbls/day)

[a] Definitions:
E3 is 1,000
E6 is 1,000,000
bbl is a barrel or 42 gallons
MW is one million watts
Scf is a cubic foot at standard temperature and pressure

TABLE 4-2

SCENARIO COMPARISON

	ALL COAL PRODUCTION	UNDERGROUND COAL PRODUCTION	SURFACE COAL PRODUCTION
1985 $7.00 BUSINESS AS USUAL VS 1972	NATIONAL: 33% INCREASE TO 2,257,060 TONS PER DAY	NATIONAL: 28% DECREASE TO 630,980 TONS PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION IS NEARLY IDENTICAL TO THAT OF THE 1985/AS/$11.00 CASE WITH THE EXCEPTION OF THE MIDWEST (COAL SUPPLY REGION 3) WHERE THE INCREASE IS 37% TO 198,870 TONS PER DAY	NATIONAL: 110% INCREASE TO 1,626,080 TONS PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION IS NEARLY IDENTICAL TO THAT OF THE 1985/AS/$11.00 CASE WITH THE EXCEPTION OF THE TEXAS-LOUISIANA REGION (COAL SUPPLY REGION 4) WHERE THE INCREASE IS [illegible] TO [illegible] TONS PER DAY AND THE ROCKY MOUNTAIN REGION (COAL SUPPLY REGION 6) WHERE THE INCREASE IS [illegible] TO 347,530 TONS PER DAY
1985 $7.00 ACCELERATED SUPPLY VS 1972	NATIONAL: 47% INCREASE TO 2,393,090 TONS PER DAY	NATIONAL: 20% DECREASE TO 702,420 TONS PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION IS IDENTICAL TO THAT OF THE BAU CASE AND THE 1985/AS/$11.00 CASE, AGAIN WITH THE EXCEPTION OF THE MIDWEST (COAL SUPPLY REGION 3) WHERE THE INCREASE IS 56% TO 275,290 TONS PER DAY	NATIONAL: 124% INCREASE TO 1,690,670 TONS PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION IS NEARLY IDENTICAL TO THAT OF THE BAU CASE
1985 $11.00 BUSINESS AS USUAL VS 1972	NATIONAL: 106% INCREASE TO 3,367,650 TONS PER DAY	NATIONAL: 43% INCREASE TO 1,251,300 TONS PER DAY MAJOR REGIONAL ASPECTS 1. MIDWEST (COAL SUPPLY REGION 3) - 360% INCREASE TO 667,700 TONS PER DAY 2. NORTHERN APPALACHIA (COAL SUPPLY REGION 1) - 40% DECLINE TO 135,060 TONS PER DAY	NATIONAL: 181% INCREASE TO 2,116,350 TONS PER DAY MAJOR REGIONAL ASPECTS 1. MAJOR INCREASES IN ALL REGIONS EXCEPT IN THE NORTHERN GREAT PLAINS AND THE PACIFIC COAST REGION (COAL SUPPLY REGIONS 5 AND 7, RESPECTIVELY) 2 MOST SUBSTANTIAL GAINS ARE IN THE TEXAS-LOUISIANA REGION (COAL SUPPLY REGION 4) UP [illegible] TO [illegible] TONS PER DAY, AND THE ROCKY MOUNTAIN REGION (COAL SUPPLY REGION 6), UP [illegible] TO 453,210 TONS PER DAY
1985 $11.00 ACCELERATED SUPPLY VS 1972	NATIONAL: 82% INCREASE TO 2,961,450 TONS PER DAY	NATIONAL: 14% INCREASE TO 995,910 TONS PER DAY MAJOR REGIONAL ASPECTS 1. MIDWEST (COAL SUPPLY REGION 3) - 292% INCREASE TO 568,720 TONS PER DAY 2. NORTHERN APPALACHIA (COAL SUPPLY REGION 1) - 45% DECREASE TO 172,490 TONS PER DAY 3. SOUTHERN APPALACHIA (COAL SUPPLY REGION 2) - 41% DECREASE TO 232,730 TONS PER DAY	NATIONAL: 161% INCREASE TO 1,965,540 TONS PER DAY MAJOR REGIONAL CHANGES SAME REGIONAL CHANGES AS PER THE BAU CASE, EXCEPT THE INCREASE IN THE TEXAS-LOUISIANA REGION (COAL SUPPLY REGION 4) IS [illegible] TO [illegible] TONS PER DAY AND THE CHANGE IN THE ROCKY MOUNTAIN REGION (COAL SUPPLY REGION 6) IS [illegible] TO [illegible] TONS PER DAY

TABLE 4-2 (CONT.)

SCENARIO COMPARISON

	OIL PRODUCTION	NATURAL GAS PRODUCTION	OIL SHALE PRODUCTION
1985 $7.00 BUSINESS AS USUAL VS 1972	NATIONAL: 4% DECREASE TO 8,678,600 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1. ALL OCS REGIONS (PETROLEUM SUPPLY REGIONS (PSR) 2a, 6a, AND 11a) AND THE ALASKA NORTH SLOPE SHOW DEVELOPMENT FROM VIRGIN AREAS IN 1972 TO PRODUCTION LEVELS NEARLY IDENTICAL TO THAT IN THE 1985/BAU/$11.00 CASE; NPR-4 IS NOT DEVELOPED 2. ALASKA (PSR 1) - DECREASES 71% TO 58,600 BARRELS PER DAY; SEEMS TO IMPLY NO DEVELOPMENT OF THE ALASKA OCS 3. WEST TEXAS (PSR 5) - DECREASES 47% TO 1,796,300 BARRELS PER DAY 4. TEXAS-LOUISIANA (PSR 6) - DECREASES 47% TO 1,516,300 BARRELS PER DAY 5. ALL OTHER REGIONS (PSR's 2, 3, 4, 7, 8-9-10, 11) SHOW PRODUCTION LEVELS NEARLY IDENTICAL TO THE 1985/AS/$11.00 CASE	NATIONAL: 29% DECREASE TO 50,055.73 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1. TEXAS-LOUISIANA (PETROLEUM SUPPLY REGION (PSR) 6) - DECLINES 57% TO 21,098.93 MILLION SCF PER DAY, ACCOUNTING FOR THE MAJOR PORTION OF THE OVERALL DECLINE 2. NORTH SLOPE OF ALASKA - NO PRODUCTION; THEREFORE NO NPR-4 DEVELOPMENT 3. ALASKA (PSR 1) - NO PRODUCTION; THEREFORE NO ALASKA OCS DEVELOPMENT 4. PACIFIC OCS (PSR 2a) - INCREASES 50% TO 331.37 MILLION SCF PER DAY 5. GULF OF MEXICO OCS (PSR 6a) - RISES 55% TO 16,473.66 MILLION SCF PER DAY 6. ATLANTIC OCS (PSR 11a) - TO 57.03 MILLION SCF PER DAY FROM A VIRGIN AREA IN 1972	TOTAL: TO 250,000 BARRELS PER DAY FROM A VIRGIN AREA IN 1972, IDENTICAL TO THE 1985/BAU/$11.00 AMOUNT METHODS ALL PRODUCTION IS SURFACE PRODUCTION; THERE IS NO "UNDERGROUND" OR "IN SITU" PRODUCTION, IDENTICAL TO THE 1985/BAU/$11.00 CASE
1985 $7.00 ACCELERATED SUPPLY VS 1972	NATIONAL: INCREASES 31% TO 12,172,900 BARRELS PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION IS IDENTICAL TO THAT OF THE BAU CASE EXCEPT FOR THE ALASKA NORTH SLOPE AND THE OCS REGIONS (PSR'S 2a, 6a, 11a) IN WHICH CASES PRODUCTION LEVELS ARE IDENTICAL TO THOSE OF THE 1985/AS/$11.00 CASE	NATIONAL: 27% DECREASE TO 55,982.62 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS MOST REGIONAL ASPECTS REMAIN RELATIVELY UNCHANGED WITH RESPECT TO THE BAU CASE - THE EXCEPTIONS ARE GREATER DEVELOPMENT OVER 1972 OF OCS AREAS (NORTH SLOPE OF ALASKA AND ALASKA REMAIN UNDEVELOPED): 1. PACIFIC OCS (PETROLEUM SUPPLY REGION (PSR) 2a) - RISES 1,239% TO 733.37 MILLION SCF PER DAY 2. GULF OF MEXICO OCS (PSR 6a) - RISES 76% TO 18,699.30 MILLION SCF PER DAY 3. ATLANTIC OCS (PSR 11a) - TO 491.49 MILLION SCF PER DAY FROM A VIRGIN AREA IN 1972	TOTAL: TO 1,000,000 BARRELS PER DAY FROM A VIRGIN AREA IN 1972, IDENTICAL TO THE 1985/AS/$11.00 AMOUNT METHODS ALL PRODUCTION IS SURFACE PRODUCTION; THERE IS NO "UNDERGROUND" OR "IN SITU" PRODUCTION, IDENTICAL TO THE 1985/AS/$11.00 CASE
1985 $11.00 BUSINESS AS USUAL VS 1972	NATIONAL: 35% INCREASE TO 12,473,000 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1. NORTH SLOPE OF ALASKA-DEVELOPED FROM A VIRGIN AREA IN 1972 TO 2,500,000 BARRELS PER DAY, ACCOUNTING FOR THE MAJORITY OF THE OVERALL RISE; NPR-4 IS NOT DEVELOPED 2. ALASKA (PETROLEUM SUPPLY REGION (PSR) 1)-RISES 135% TO 462,200 BARRELS PER DAY, CONSEQUENCES FOR ALASKA OCS DEVELOPMENT UNCERTAIN 3. PACIFIC OCS (PSR 2a)-RISES 780% TO 516,830 BARRELS PER DAY 4. GULF OF MEXICO OCS (PSR 6a)-RISES 40% TO 1,548,400 BARRELS PER DAY 5. ATLANTIC OCS (PSR 11a)-DEVELOPED FROM A VIRGIN AREA IN 1972 TO 37,700 BARRELS PER DAY	NATIONAL: DECREASES 29% TO 50,850.61 MILLION SCF PER DAY, NEARLY IDENTICAL TO THE 1985/BAU/$11.00 AMOUNT MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION IS NEARLY IDENTICAL TO THAT OF THE 1985/BAU/$11.00 CASE	TOTAL: DEVELOPED TO 250,000 BARRELS PER DAY FROM A VIRGIN AREA IN 1972 UNDERGROUND: NO DEVELOPMENT SURFACE: ACCOUNTS FOR ALL DEVELOPMENT AT 250,000 BARRELS PER DAY IN SITU: NO DEVELOPMENT
1985 $11.00 ACCELERATED SUPPLY VS 1972	NATIONAL: 53% INCREASE TO 14,196,930 BARRELS PER DAY MAJOR REGIONAL ASPECTS ALL REGIONS VIRGIN IN 1972 AND ALL OCS REGIONS SHOW GREATER INCREASES THAN THE BAU CASE OVER 1972 PRODUCTION: 1. NORTH SLOPE OF ALASKA - TO 4,500,700 BARRELS PER DAY FROM A VIRGIN AREA IN 1972; NPR-4 IS DEVELOPED TO 2,000,000 BARRELS PER DAY 2. ALASKA (PETROLEUM SUPPLY REGION (PSR) 1) - UP 292% TO 781,900 BARRELS PER DAY; CONSEQUENCES FOR ALASKA OCS UNCERTAIN 3. PACIFIC OCS (PSR 2a) - UP 1,652% TO 1,121,600 BARRELS PER DAY 4. GULF OF MEXICO OCS (PSR 6a) - UP 61% TO 1,785,406 BARRELS PER DAY 5. ATLANTIC OCS (PSR 11a) - TO 478,500 BARRELS PER DAY FROM A VIRGIN AREA IN 1972	NATIONAL: DECREASES 27% TO 55,982.62 MILLION SCF PER DAY, IDENTICAL TO THE 1985 AS/$11.00 AMOUNT MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION IS IDENTICAL TO THAT OF THE 1985/AS/$11.00 CASE	TOTAL: DEVELOPED TO 1,000,000 BARRELS PER DAY FROM A VIRGIN AREA IN 1972 UNDERGROUND: NO DEVELOPMENT SURFACE: ACCOUNTS FOR ALL DEVELOPMENT AT 1,000,000 BARRELS PER DAY IN SITU: NO DEVELOPMENT

TABLE 4-2 (CONT.)

SCENARIO COMPARISON

	COAL GASIFICATION	COAL LIQUEFACTION	REFINERIES
1985 $7.00 BUSINESS AS USUAL VS 1972	NATIONAL: NO COAL GASIFICATION	NATIONAL: NO COAL LIQUEFACTION	NATIONAL: INCREASES 24% TO 17,119,470 BARRELS PER DAY MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION APPROACHES THAT OF THE 1985/BAU/$11.00 CASE
1985 $7.00 ACCELERATED SUPPLY VS 1972	NATIONAL: TO 324.80 MILLION SCF PER DAY FROM NO CONVERSION IN 1972 MAJOR REGIONAL ASPECTS CONVERSION ONLY IN THE NORTHERN GREAT PLAINS AND THE ROCKY MOUNTAINS REGIONS (COAL SUPPLY REGIONS 5 AND 6) WHERE LEVELS ARE IDENTICAL TO THOSE IN THE 1985/AS/$11.00 CASE	NATIONAL: TO 56,000 BARRELS PER DAY FROM NO CONVERSION IN 1972 MAJOR REGIONAL ASPECTS CONVERSION ONLY IN THE NORTHERN GREAT PLAINS AND THE ROCKY MOUNTAINS REGION (COAL SUPPLY REGIONS 5 AND 6) WHERE LEVELS ARE IDENTICAL TO THOSE IN THE 1985/AS/$11.00 CASE	NATIONAL: INCREASES 29% TO 17,803,000 BARRELS PER DAY MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION APPROACHES THAT OF THE BAU CASE AND THE 1985/BAU/$11.00 CASE
1985 $11.00 BUSINESS AS USUAL VS 1972	NATIONAL: NO COAL GASIFICATION	NATIONAL: NO DEVELOPMENT OF COAL LIQUEFACTION	NATIONAL: INCREASES 18% TO 16,332,250 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1. SOUTHEAST (PAD 1B) - INCREASES 5.233% TO 5,385,850 BARRELS PER DAY 2. MIDWEST (PAD 2A) - DECREASES 78% TO 483,160 BARRELS PER DAY
1985 $11.00 ACCELERATED SUPPLY VS 1972	NATIONAL: TO 464.00 MILLION SCF PER DAY FROM NO CONVERSION IN 1972 MAJOR REGIONAL ASPECTS THE FOLLOWING ARE THE ONLY REGIONS WHERE DEVELOPMENT OF COAL GASIFICATION OCCURS: 1. NORTHERN APPALACHIA (COAL SUPPLY REGION (CSR) 1) - TO 92.80 MILLION SCF PER DAY 2. SOUTHERN APPALACHIA (CSR 2) - TO 46.40 MILLION SCF PER DAY 3. NORTHERN GREAT PLAINS (CSR 5) - TO 139.20 MILLION SCF PER DAY 4. ROCKY MOUNTAINS (CSR 6) - TO 185.60 MILLION SCF PER DAY	NATIONAL: TO 80,000 BARRELS PER DAY FROM NO CONVERSION IN 1972 MAJOR REGIONAL ASPECTS THE FOLLOWING ARE THE ONLY REGIONS WHERE DEVELOPMENT OF COAL LIQUEFACTION OCCURS: 1. NORTHERN APPALACHIA (COAL SUPPLY REGION (CSR) 1) - TO 16,000 BARRELS PER DAY 2. SOUTHERN APPALACHIA (CSR 2) - TO 8,000 BARRELS PER DAY 3. NORTHERN GREAT PLAINS (CSR 5) - TO 24,000 BARRELS PER DAY 4. ROCKY MOUNTAINS (CSR 6) - TO 32,000 BARRELS PER DAY	NATIONAL: INCREASES 18% TO 16,338,770 BARRELS PER DAY MAJOR REGIONAL ASPECTS NO MAJOR CHANGES FROM THE BAU CASE AS COMPARED WITH 1972

TABLE 4-2 (CONT.)

SCENARIO COMPARISON

	COAL-FIRED POWER PLANTS	OIL-FIRED POWER PLANTS	NATURAL GAS-FIRED POWER PLANTS
1985 $7.00 BUSINESS AS USUAL VS 1972	NATIONAL: INCREASES 56% TO 1,365,870 TONS PER DAY MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION APPROACHES THAT OF THE 1985/AS/$11.00 CASE	NATIONAL: INCREASES 160% TO 2,575,870 BARRELS PER DAY MAJOR REGIONAL ASPECTS DISTRIBUTION OF THE INCREASE AMONG THE REGIONS IS FAIRLY UNIFORM	NATIONAL: DECREASES 24% TO 7,112.48 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION APPROACHES THAT OF THE 1985/AS/$11.00 CASE
1985 $7.00 ACCELERATED SUPPLY VS 1972	NATIONAL: INCREASES 64% TO 1,432,870 TONS PER DAY MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION IS NEARLY IDENTICAL TO THAT OF THE BAU CASE AND APPROACHES THAT OF THE 1985/AS/$11.00 CASE	NATIONAL: INCREASES 195% TO 3,371,580 BARRELS PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION APPROACHES THAT OF THE BAU CASE	NATIONAL: DECREASES 25% TO 7,035.52 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION IS NEARLY IDENTICAL TO THAT OF THE BAU CASE
1985 $11.00 BUSINESS AS USUAL VS 1972	NATIONAL: INCREASES 159% TO 2,365,830 TONS PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION IS RELATIVELY UNIFORM	NATIONAL: INCREASES 51% TO 1,773,410 BARRELS PER DAY MAJOR REGIONAL ASPECTS EVENLY DISTRIBUTED INCREASE AMONG THE REGIONS INCLUDING THE INTRODUCTION OF 37,410 BARRELS PER DAY IN TEXAS (ELECTRIC UTILITY REGION (EUR) 7) WHERE NO OIL WAS BURNED IN POWER PLANTS IN 1972. THE NEW ENGLAND REGION (EUR 1), HOWEVER, SHOWS A [illegible] FALL TO 176,470 BARRELS PER DAY	NATIONAL: DECREASES 48% TO 4,865.88 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS THE FOLLOWING ACCOUNT FOR THE MAJORITY OF THE DECREASE: 1. SOUTH CENTRAL (ELECTRIC UTILITY REGION (EUR) 8) - DOWN 39% TO 2,405.570 MILLION SCF PER DAY 2. WEST (EUR 9) - DOWN 97% TO 75.17 MILLION SCF PER DAY
1985 $11.00 ACCELERATED SUPPLY VS 1972	NATIONAL: INCREASES 114% TO 1,872,990 TONS PER DAY MAJOR REGIONAL ASPECTS NO MAJOR CHANGES FROM THE BAU CASE AS COMPARED WITH 1972	NATIONAL: INCREASES 51% TO 1,729,930 BARRELS PER DAY MAJOR REGIONAL ASPECTS NO MAJOR CHANGES FROM THE BAU CASE AS COMPARED WITH 1972	NATIONAL: DECREASES 31% TO 6,016.73 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS NO MAJOR CHANGES FROM THE BAU CASE AS COMPARED WITH 1972

TABLE 4-2 (CONT.)

SCENARIO COMPARISON

	HYDRO-ELECTRIC POWER PLANTS	NUCLEAR POWER PLANTS
1985 $7.00 BUSINESS AS USUAL VS 1972	NATIONAL: INCREASES 152% TO 195.09 GIGAWATTS, IDENTICAL TO THAT OF THE 1985/$11.00 CASES MAJOR REGIONAL ASPECTS REGIONAL GENERATION IS IDENTICAL TO THAT OF THE 1985/$11.00 CASES	NATIONAL: INCREASES 2,423% TO 0.558 TONS OF U-235 PER DAY, IDENTICAL TO THE 1985/BAU/$11.00 CASE MAJOR REGIONAL ASPECTS REGIONAL U-235 INPUTS ARE THE SAME AS FOR THE 1985/BAU/$11.00 CASE
1985 $7.00 ACCELERATED SUPPLY VS 1972	NATIONAL: INCREASES 152% TO 195.09 GIGAWATTS, IDENTICAL TO THAT OF THE 1985/$11.00 CASES AND THE BAU CASE MAJOR REGIONAL ASPECTS REGIONAL GENERATION IS IDENTICAL TO THAT OF THE 1985/$11.00 CASES AND THE BAU CASE	NATIONAL: INCREASES 2,854% TO 0.700 TONS OF U-235 PER DAY, IDENTICAL TO THE 1985/AS/$11.00 CASE MAJOR REGIONAL ASPECTS REGIONAL U-235 INPUTS ARE THE SAME AS FOR THE 1985/AS/$11.00 CASE
1985 $11.00 BUSINESS AS USUAL VS 1972	NATIONAL: INCREASES 152% TO 195.09 GIGAWATTS MAJOR REGIONAL ASPECTS INCREASE DISTRIBUTED FAIRLY EVENLY WITH THE EXCEPTION OF A LARGE INCREASE IN THE WEST OF 112% TO 111.17 GIGAWATTS (ELECTRIC UTILITY REGION 9)	NATIONAL: INCREASES 2,423% TO 0.558 TONS OF U-235 PER DAY MAJOR REGIONAL ASPECTS THE REGIONAL DISTRIBUTION IS RELATIVELY UNIFORM
1985 $11.00 ACCELERATED SUPPLY VS 1972	NATIONAL: INCREASES 152% TO 195.09 GIGAWATTS, IDENTICAL TO GENERATION IN THE BAU CASE MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION IS IDENTICAL TO THAT OF THE BAU CASE	NATIONAL: INCREASES 2,854% TO 0.700 TONS OF U-235 PER DAY MAJOR REGIONAL ASPECTS NO MAJOR CHANGES FROM THE BAU CASE AS COMPARED WITH 1972

TABLE 4-3

PRICE COMPARISON

RESOURCE ACTIVITY	1985 BUSINESS AS USUAL/$11.00 VS BUSINESS AS USUAL/$7.00	1985 ACCELERATED SUPPLY/$11.00 VS ACCELERATED SUPPLY/$7.00
ALL COAL PRODUCTION	NATIONAL: PRODUCTION OF ALL COAL IS 33% LESS AT 2,257,000 TONS PER DAY FOR THE $7.00 CASE THAN THE $11.00 CASE AT 3,367,650 TONS PER DAY	NATIONAL: PRODUCTION OF ALL COAL IS 19% LESS AT 2,393,040 TONS PER DAY FOR THE $7.00 CASE THAN THE $11.00 CASE AT 2,961,450 TONS PER DAY
UNDERGROUND COAL PRODUCTION	NATIONAL: THE $7.00 CASE AT 630,920 TONS PER DAY IS 50% LESS THAN THE $11.00 CASE AT 1,251,300 TONS PER DAY MAJOR REGIONAL ASPECTS 1. MIDWEST (COAL SUPPLY REGION 3) - AT 198,870 TONS PER DAY THE $7.00 CASE IS 70% LESS THAN THE $11.00 CASE AT 667,760 TONS PER DAY	NATIONAL: THE $7.00 CASE OF 702,420 TONS PER DAY IS 29% LESS THAN THE $11.00 CASE AT 995,910 TONS PER DAY MAJOR REGIONAL ASPECTS 1. MIDWEST (COAL SUPPLY REGION 3) - AT 275,290 TONS PER DAY THE $7.00 CASE IS 52% LESS THAN THE $11.00 CASE AT 568,780 TONS PER DAY
SURFACE COAL PRODUCTION	NATIONAL: THE $7.00 CASE AT 1,626,080 TONS PER DAY IS 23% LESS THAN THE $11.00 CASE AT 2,116,350 TONS PER DAY MAJOR REGIONAL ASPECTS 1. TEXAS-LOUISIANA (COAL SUPPLY REGION (CSR) 4) - AT 63,800 TONS PER DAY THE $7.00 CASE IS 83% LESS THAN THE $11.00 CASE AT 414,510 TONS PER DAY 2. ROCKY MOUNTAIN (CSR 6) - AT 347,534 TONS PER DAY THE $7.00 CASE IS 30% LESS THAN THE $11.00 CASE AT 493,218 TONS PER DAY	NATIONAL: THE $7.00 CASE AT 1,690,620 TONS PER DAY IS 14% LESS THAN THE $11.00 CASE AT 1,965,540 TONS PER DAY MAJOR REGIONAL ASPECTS 1. TEXAS-LOUISIANA (COAL SUPPLY REGION 4) - AT 68,820 TONS PER DAY THE $7.00 CASE IS 76% LESS THAN THE $11.00 CASE AT 432,310 TONS PER DAY
OIL PRODUCTION	NATIONAL: THE $7.00 CASE AT 8,878,600 BARRELS PER DAY IS 29% LESS THAN THE $11.00 CASE AT 12,473,000 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1. NORTH SLOPE OF ALASKA AND ALL OCS REGIONS (PETROLEUM SUPPLY REGIONS (PSR) 2A, 6A, 11A) - ARE THE SAME FOR BOTH THE $7.00 AND THE $11.00 CASE 2. WEST TEXAS (PSR 5) - AT 1,196,100 BARRELS PER DAY THE $7.00 CASE IS 48% LESS THAN THE $11.00 CASE AT 2,304,500 BARRELS PER DAY 3. TEXAS-LOUISIANA (PSR 6) - AT 1,516,300 BARRELS PER DAY THE $7.00 CASE IS 36% LESS THAN THE $11.00 CASE AT 2,382,200 BARRELS PER DAY	NATIONAL: THE $7.00 CASE AT 12,172,900 BARRELS PER DAY IS 14% LESS THAN THE $11.00 CASE AT 14,196,930 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1. NORTH SLOPE OF ALASKA AND ALL OCS REGIONS (PETROLEUM SUPPLY REGIONS (PSR) 2A, 6A, 11A) - ARE THE SAME FOR BOTH THE $7.00 AND THE $11.00 CASE 2. TEXAS-LOUISIANA (PSR 6) - AT 1,516,300 BARRELS PER DAY THE $7.00 CASE IS 38% LESS THAN THE $11.00 CASE AT 2,459,100 BARRELS PER DAY
NATURAL GAS PRODUCTION	NATIONAL: THE $7.00 CASE AT 50,890.61 MILLION SCF PER DAY IS NEARLY IDENTICAL TO THE $11.00 CASE AT 50,885.76 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION IS NEARLY IDENTICAL FOR THE $7.00 AND $11.00 CASES	NATIONAL: THE $7.00 CASE AT 55,982.62 MILLION SCF PER DAY IS IDENTICAL TO THE $11.00 CASE REGIONAL ASPECTS REGIONAL DISTRIBUTION IS IDENTICAL FOR THE $7.00 AND $11.00 CASES
OIL SHALE PRODUCTION	TOTAL: THE $7.00 CASE AT 250,000 BARRELS PER DAY IS IDENTICAL TO THE $11.00 CASE METHODS BOTH THE $7.00 AND $11.00 CASES SHOW ALL PRODUCTION FROM THE SURFACE METHOD, AND NO PRODUCTION FROM "UNDERGROUND" OR "IN SITU" METHODS	TOTAL: THE $7.00 CASE AT 1,000,000 BARRELS PER DAY IS IDENTICAL TO THE $11.00 CASE METHODS BOTH THE $7.00 AND $11.00 CASES SHOW ALL PRODUCTION FROM THE SURFACE METHOD, AND NO PRODUCTION FROM "UNDERGROUND" OR "IN SITU" METHODS.
COAL GASIFICATION	NATIONAL: NEITHER THE $7.00 NOR THE $11.00 CASE SHOWS ANY DEVELOPMENT"	NATIONAL: THE $7.00 CASE AT 326.30 MILLION SCF PER DAY IS 30% LESS THAN THE $11.00 CASE AT 464.10 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS WHILE THERE IS NO DEVELOPMENT IN THE NORTHERN AND SOUTHERN APPALACHIA (COAL SUPPLY REGIONS 1 AND 2) IN THE $7.00 CASE, THE $11.00 CASE SHOWS DEVELOPMENT TO 52.80 AND 46.40 MILLION SCF PER DAY, RESPECTIVELY

TABLE 4-3 (CONT.)

PRICE COMPARISON

RESOURCE ACTIVITY	1985 BUSINESS AS USUAL/$11.00 VS BUSINESS AS USUAL/$7.00	1985 ACCELERATED SUPPLY/$11.00 VS ACCELERATED SUPPLY/$7.00
COAL LIQUEFACTION	NATIONAL: NEITHER THE $7.00 NOR THE $11.00 CASE SHOWS ANY DEVELOPMENT	NATIONAL: THE $7.00 CASE AT 56,000 BARRELS PER DAY IS 30% LESS THAN THE $11.00 CASE AT 80,000 BARRELS PER DAY MAJOR REGIONAL ASPECTS WHILE THERE IS NO DEVELOPMENT IN NORTHERN AND SOUTHERN APPALACHIA (COAL SUPPLY REGIONS 1 AND 2) IN THE $7.00 CASE, THE $11.00 CASE SHOWS DEVELOPMENT TO 16,000 AND 8,000 BARRELS PER DAY, RESPECTIVELY
REFINERIES	NATIONAL: THE $7.00 CASE AT 17,119,470 BARRELS PER DAY IS 5% GREATER THAN THE $11.00 CASE AT 16,332,250 BARRELS PER DAY MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTION IS NEARLY IDENTICAL FOR THE $7.00 AND $11.00 CASES	NATIONAL: THE $7.00 CASE AT 17,803,000 BARRELS PER DAY IS 9% GREATER THAN THE $11.00 CASE AT 16,336,770 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1. SOUTHEAST (PAD 1B) - AT 6,557,630 BARRELS PER DAY THE $7.00 CASE IS 71% GREATER THAN THE $11.00 CASE AT 3,839,660 BARRELS PER DAY 2. SOUTH CENTRAL (PAD 3) - AT 4,830,930 BARRELS PER DAY THE $7.00 CASE IS 21% LESS THAN THE $11.00 CASE AT 6,111,730 BARRELS PER DAY
COAL-FIRED POWER PLANTS	NATIONAL: THE $7.00 CASE AT 1,365,620 TONS PER DAY IS 40% LESS THAN THE $11.00 CASE AT 2,265,630 TONS PER DAY MAJOR REGIONAL ASPECTS DISTRIBUTION OF THE DIFFERENCE BETWEEN THE $7.00 AND $11.00 CASES AMONG THE REGIONS IS FAIRLY UNIFORM	NATIONAL: THE $7.00 CASE AT 1,432,870 TONS PER DAY IS 23% LESS THAN THE $11.00 CASE AT 1,872,940 TONS PER DAY MAJOR REGIONAL ASPECTS DISTRIBUTION OF THE DIFFERENCE BETWEEN THE $7.00 AND $11.00 CASES AMONG THE REGIONS IS FAIRLY UNIFORM
OIL-FIRED POWER PLANTS	NATIONAL: THE $7.00 CASE AT 2,975,870 BARRELS PER DAY IS 73% GREATER THAN THE $11.00 CASE AT 1,723,410 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1. NORTHEAST (ELECTRIC UTILITY REGION (EUR) 6) - AT 677,900 BARRELS PER DAY THE $7.00 CASE IS 284% GREATER THAN THE $11.00 CASE AT 176,470 BARRELS PER DAY 2. MIDWEST (EUR 1) - AT 628,710 BARRELS PER DAY THE $7.00 CASE IS 139% GREATER THAN THE $11.00 CASE AT 263,000 BARRELS PER DAY	NATIONAL: THE $7.00 CASE AT 3,371,590 BARRELS PER DAY IS 95% GREATER THAN THE $11.00 CASE AT 1,729,500 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1. MIDWEST (ELECTRIC UTILITY REGION (EUR) 1) - AT 692,360 BARRELS PER DAY IS 156% GREATER THAN THE $11.00 CASE AT 272,890 BARRELS PER DAY 2. EAST NORTH CENTRAL (EUR 4) - AT 357,660 BARRELS PER DAY THE $7.00 CASE IS 333% GREATER THAN THE $11.00 CASE AT 82,560 BARRELS PER DAY 3. NORTHEAST (EUR 6) - AT 660,420 BARRELS PER DAY IS 276% GREATER THAN THE $11.00 CASE AT 175,420 BARRELS PER DAY
NATURAL GAS-FIRED POWER PLANTS	NATIONAL: THE $7.00 CASE AT 7,112.43 MILLION SCF PER DAY IS 46% GREATER THAN THE $11.00 CASE AT 4,869.58 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1. TEXAS (ELECTRIC UTILITY REGION (EUR) 2) - AT 3,154.33 MILLION SCF PER DAY THE $7.00 CASE IS 45% GREATER THAN THE $11.00 CASE AT 2,172.90 MILLION SCF PER DAY 2. SOUTH CENTRAL (EUR 8) - AT 3,211.87 MILLION SCF PER DAY THE $7.00 CASE IS 33% GREATER THAN THE $11.00 CASE AT 2,405.92 MILLION SCF PER DAY 3. WEST (EUR 9) - AT 576.21 MILLION SCF PER DAY THE $7.00 CASE IS 666% GREATER THAN THE $11.00 CASE AT 75.17 MILLION SCF PER DAY	NATIONAL: THE $7.00 CASE AT 7,035.52 MILLION SCF PER DAY IS 17% GREATER THAN THE $11.00 CASE AT 6,016.73 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1. TEXAS (ELECTRIC UTILITY REGION 2) - AT 3,120.12 MILLION SCF PER DAY THE $7.00 CASE IS 25% GREATER THAN THE $11.00 CASE AT 2,501.28 MILLION SCF PER DAY
HYDRO-ELECTRIC POWER PLANTS	NATIONAL: THE $7.00 CASE AT 195.09 GIGAWATTS IS IDENTICAL TO THE $11.00 CASE MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTIONS FOR THE $7.00 AND $11.00 CASES ARE IDENTICAL	NATIONAL: THE $7.00 CASE AT 195.09 GIGAWATTS IS IDENTICAL TO THE $11.00 CASE MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTIONS FOR THE $7.00 AND $11.00 CASES ARE IDENTICAL
NUCLEAR POWER PLANTS	NATIONAL: THE $7.00 CASE AT 0.598 TONS OF U-235 PER DAY IS IDENTICAL TO THE $11.00 CASE MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTIONS OF THE $7.00 AND $11.00 CASES ARE IDENTICAL	NATIONAL: THE $7.00 CASE OF 0.700 TONS OF U-235 PER DAY IS IDENTICAL TO THE $11.00 CASE MAJOR REGIONAL ASPECTS REGIONAL DISTRIBUTIONS OF THE $7.00 AND $11.00 CASES ARE IDENTICAL

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- Nuclear power generation increases over 20 fold;
- Hydroelectric capacity increases by 152 percent.

In addition to the trends shown in all scenarios, the major differences among the scenarios are listed below.

At a given price of imported oil, Accelerated Supply, compared to Business as Usual, has:

- Higher domestic oil and natural gas production;
- Higher nuclear power generation;
- Higher oil shale production;
- Development of synthetics.

For a given scenario, $7 per barrel of imported oil when compared to $11, causes:

- Higher imports of oil;
- Lower domestic oil production;
- Lower coal production;
- Lower coal-fired power generation;
- Higher oil-fired and gas-fired power generation;
- Slightly higher refining production.

4.3 Analysis

The major findings presented in the section are:

- While domestic energy production increases from the 1972 level by over 50 percent under all scenarios, almost all pollution loadings either increase only slightly or decline from 1972 levels. This is due to the assumption that more efficient pollution control technology will be applied in 1985.
- If advanced pollution control technology is not applied, pollutant loadings will increase by large amounts.
- The major differences among scenarios at the national level are:

1) Solids loadings are much greater under the Accelerated Supply scenarios because there is four times as much shale oil production as under the Business as Usual scenarios.

2) Maximum incremental land use is greater at $11 per barrel of imported oil than at $7 due to more extensive surface mining of coal.

- Apparently, from the national analysis, the major pollutant problems due to energy development in 1985 will be caused by thermal water pollution, by particulates and nitrogen oxides in the air and especially by land use.

Table 4-4 summarizes the changes in energy pollution loadings between 1972 and 1985 for each scenario. Table 4-4 also shows the consequences of not making further advances in the application of control technology. The fifth column shows changes in pollution loadings from 1972 to 1985 with the application of 1972 control technology on a 1985 scenario. In almost all cases, loadings are very much less with the application of advanced pollution control technology than with 1972 technology. Thus, the application of control technology is a central issue in the development of national energy policy (see Section 4.5).

Comparison among scenarios and to 1972 shows:

Water Pollutants:

Acids - Due to predicted complete control of acids, there are no acid loadings for any 1985 scenario. The control of acids causes slightly increased loadings of bases.

Bases - Bases increase over 1972 levels by 33 to 95 percent depending on the scenario. The $11 scenarios show the largest increase. Increased bases are due to corresponding increases in coal extraction. Total base loadings under all scenarios are small in absolute values.

Total Dissolved Solids - There is a reduction in all scenarios to one-seventh the 1972 level. Most of the reduction is due to control of the loadings associated with coal mining.

TABLE 4-4

PERCENT CHANGE IN NATIONAL ENERGY POLLUTION LOADINGS 1972 TO 1985

	BAU $7	BAU $11	AS $7	AS $11	AS/$11 w/1972[a] CONTROL TECHNOLOGY
Acids	No acid loadings in 1985				+32
Bases[b]	+35	+84	+40	+61	+5
Total Dissolved Solids	-86	-84	-85	-85	+43
Suspended Solids	-97	-96	-97	-97	+90
Organics	-77	-72	-57	-51	+59
Thermal	+25	+22	+32	+23	+80
Particulates	+23	+26	+40	+29	+68
NO(x)	+31	+51	+37	+38	+73
SO(x)	-20	- 9	-17	-17	+70
Hydrocarbons	-43	-43	-38	-39	-10
Carbon Monoxide	-87	-83	-86	-85	+23
Aldehydes	+31	+19	+39	+20	+20
Solids	- 8	+22	+129	+148	+150
Fixed Land	+125	+126	+126	+126	+130
Max. Incremental Land	-25	+36	-11	+10	+21

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[a] This represents the loading increments that would occur if existing control technology was applied to the AS $11 scenario.

[b] Base loadings are small in quantity.

Suspended Solids - In all scenarios suspended solids loadings are reduced to about 4 percent of the 1972 levels. This is due to total control of suspended solids from power plants and partial control of suspended solids from refineries and coal mining.

Organics - Organics loadings decrease 50 to 67 percent from 1972 levels, depending on the scenario. The decrease is due to tight control of refinery effluents (the major contributor in 1972). Organics due to oil production increase over 1972 to the point where oil production is the major contributor to organics loadings in 1985. Differences in organics loadings among scenarios are due to differences in oil production levels. Organics loadings (as well as other loadings) do not include transportation (i.e., oil spills).

Thermal - Thermal pollution rises about 25 percent over 1972 for all scenarios despite a greater than 25 percent increase in electricity generation. This is due to installation of abatement equipment.

Air Pollutants:

Particulates - Particulates loadings in all 1985 scenarios increase about 25 to 30 percent over 1972, corresponding closely to increases in electricity generation. Differences between scenarios are caused primarily by different levels of oil shale development. The increases reflect, in part, the advanced state of particulates control technology in 1972.

Nitrogen Oxide - Nitrogen oxide loadings increase over 1972 on the order of 40 percent for each scenario, corresponding closely to increases in coal-fired electricity generation.

Sulfur Oxide - Sulfur oxide loadings decrease slightly in each scenario from 1972 due to the assumed use of low sulfur fuel and stack gas scrubbers.

Hydrocarbons - 1972 hydrocarbon emissions are nearly halved for each 1985 scenario. This is mainly attributable to the sharp decrease in natural gas production (the major contributor to hydrocarbon totals). Hydrocarbon emissions from refineries are reduced almost 80 percent due to control technology.

Carbon Monoxide - Loadings of carbon monoxide are reduced to one-seventh or one-eighth of 1972 loadings. This is entirely due to control techniques applied to refinery emissions (the major contributor in 1972).

Aldehydes - Aldehyde loadings increase only slightly from 1972, reflecting increases in oil-fired power generation and refinery production.

Land Use:

Solids - Solids more than double over 1972 for the Accelerated Supply scenarios, reflecting significant oil shale development. Solids increase slightly in the Business as Usual $11 scenario because of some oil shale development and a substantial rise in solids from coal-fired power plants (scrubber sludge). In 1985, solids from coal mining decline significantly from 1972, since 1972 solids loadings include the overburden from unreclaimed surface mines.

Fixed Land - Because the FEA model predicts that the hydroelectric capacity will be more than double its 1972 level, fixed land increases from almost 16 million acres to over 35 million acres in each scenario.

Maximum Incremental Land - There are large differences among scenarios in the amount of maximum incremental land. They are partially due to different levels of oil shale development, but mostly due to variations in the amount of land subsidence from underground coal mining. The variations range from 25 percent less than 1972 to 30 percent more than 1972. Maximum incremental land impacts from underground coal mining vary from 1.2 million acres in the Business as Usual $7 case to 2.3 million acres in the Business as Usual $11 scenario. Maximum incremental land from surface mining increases slightly while production more than doubles, reflecting improved strip mine reclamation procedures.

Figure 4-1 depicts graphically the predicted national pollution loadings for 1972 and for each scenario. A comprehensive regional analysis is contained in Appendix A.

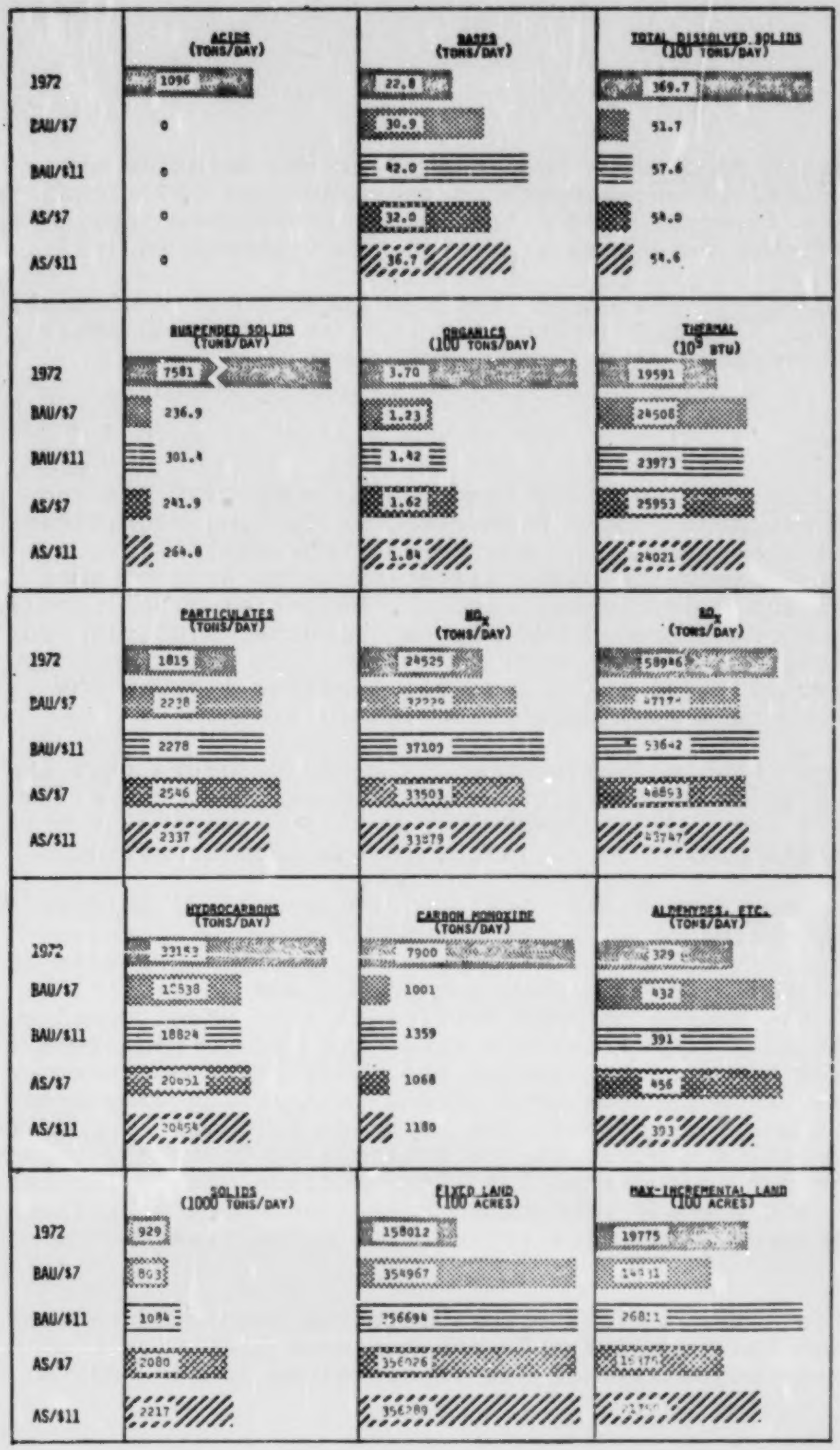

FIGURE 4-1

NATIONAL POLLUTION LOADINGS

Figures 4-2 through 4-5 show areas where primary standards for SO(X) and particulates were violated in 1972 and where there would be increased loadings in 1985. The maps show that there is little difference among scenarios in the location of areas with serious air pollution problems. Significantly, the areas of serious air pollution problems are also areas of high population density, including the East Coast and the Great Lakes Region.

Predicted radiation loadings for each 1985 scenario are shown in Table 4-5. These loadings are based on the assumption of "normal" operation (i.e., no nuclear accidents) and compliance with all radiation standards).[1,2] Table 4-6 presents loadings of non-radioactive pollutants from the entire uranium fuel cycle except nuclear power plants. These loadings are those predicted for mining, milling, uranium hexaflouride production, fabrication, reprocessing and waste disposal.

4.4 Comparison of Scenarios

The purpose of this project is to compare the environmental effects among FEA scenarios. In order to rank the various energy development strategies according to environmental impact, values of their impacts must be assessed and compared. Such a comparison requires a relative value judgement of the impacts. This means that each of the 15 pollutants in this analysis must be assigned a value comparing it to each other pollutant (e.g., hydrocarbons are twice as important as carbon monoxide, etc.). Moreover, regional impacts must similarly be valued. Particularly sensitive regions must be determined and assigned values commensurate with their relative importance.

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[1] U.S. Atomic Energy Commission, Environmental Survey of the Uranium Fuel Cycle, (Washington, D.C.), April 1974.

[2] U.S. Environmental Protection Agency, Office of Radiation Programs, Environmental Analysis of the Uranium Fuel Cycle, Part I-Fuel Supply, Part II-Nuclear Power Reactors, Part III-Nuclear Fuel Reprocessing, (Washington, D.C.), October 1973.

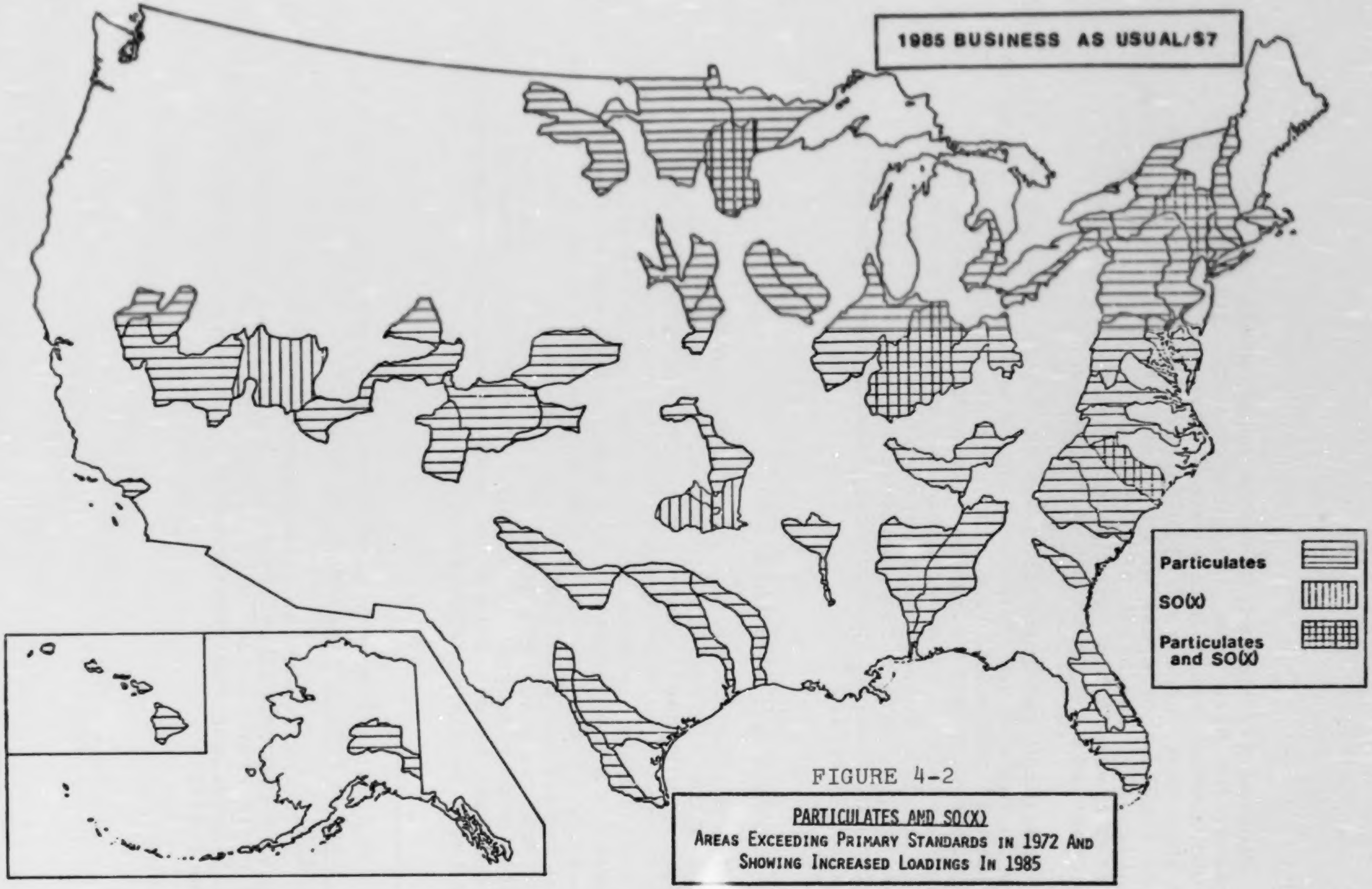

1985 BUSINESS AS USUAL/$7
Particulates
SO(X)
Particulates and SO(X)

FIGURE 4-2

PARTICULATES AND SO(X)

AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

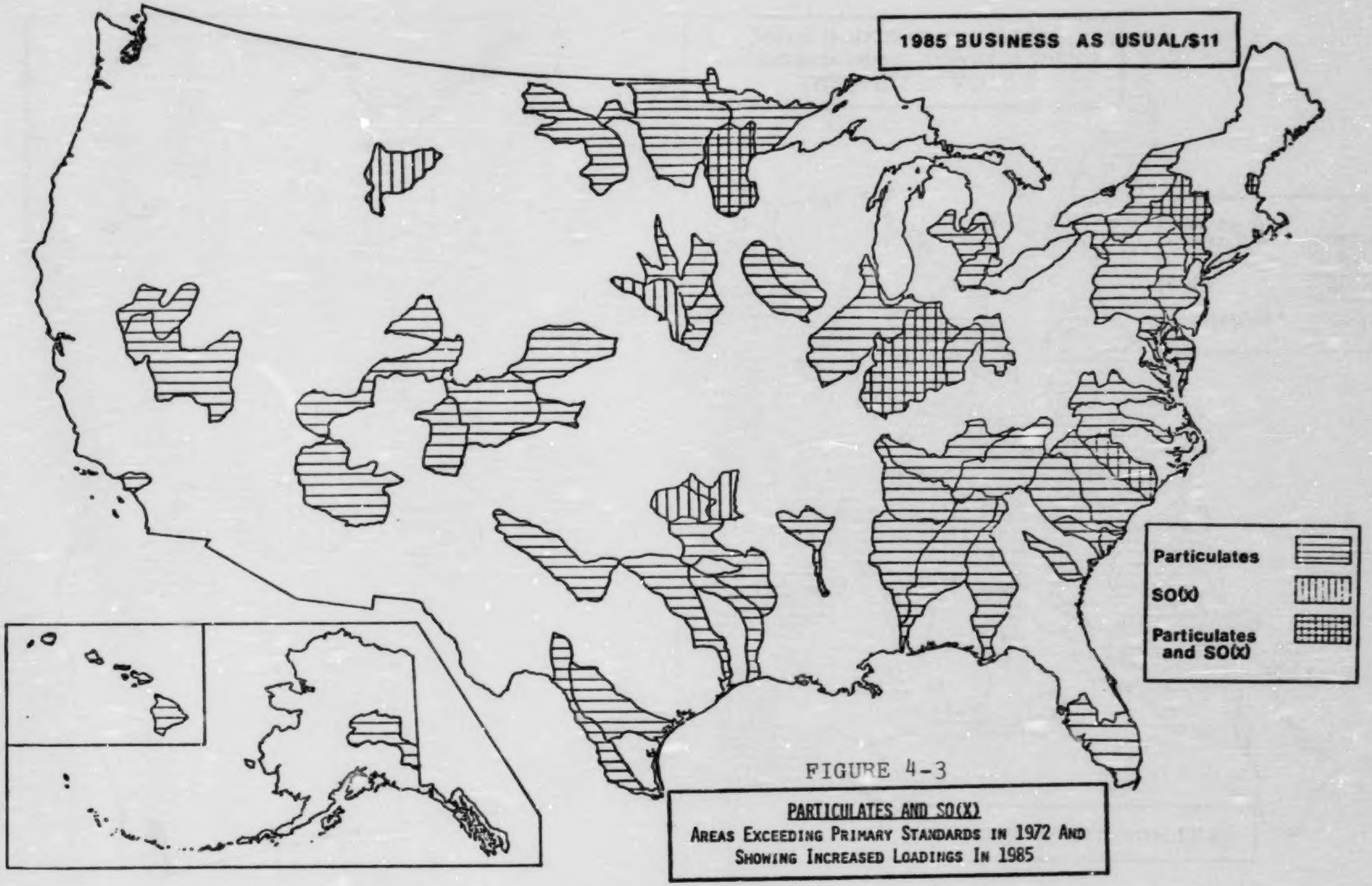

1985 BUSINESS AS USUAL/$11
Particulates ▤
SO(X) ▥
Particulates and SO(X) ▦

FIGURE 4-3

PARTICULATES AND SO(X)

AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

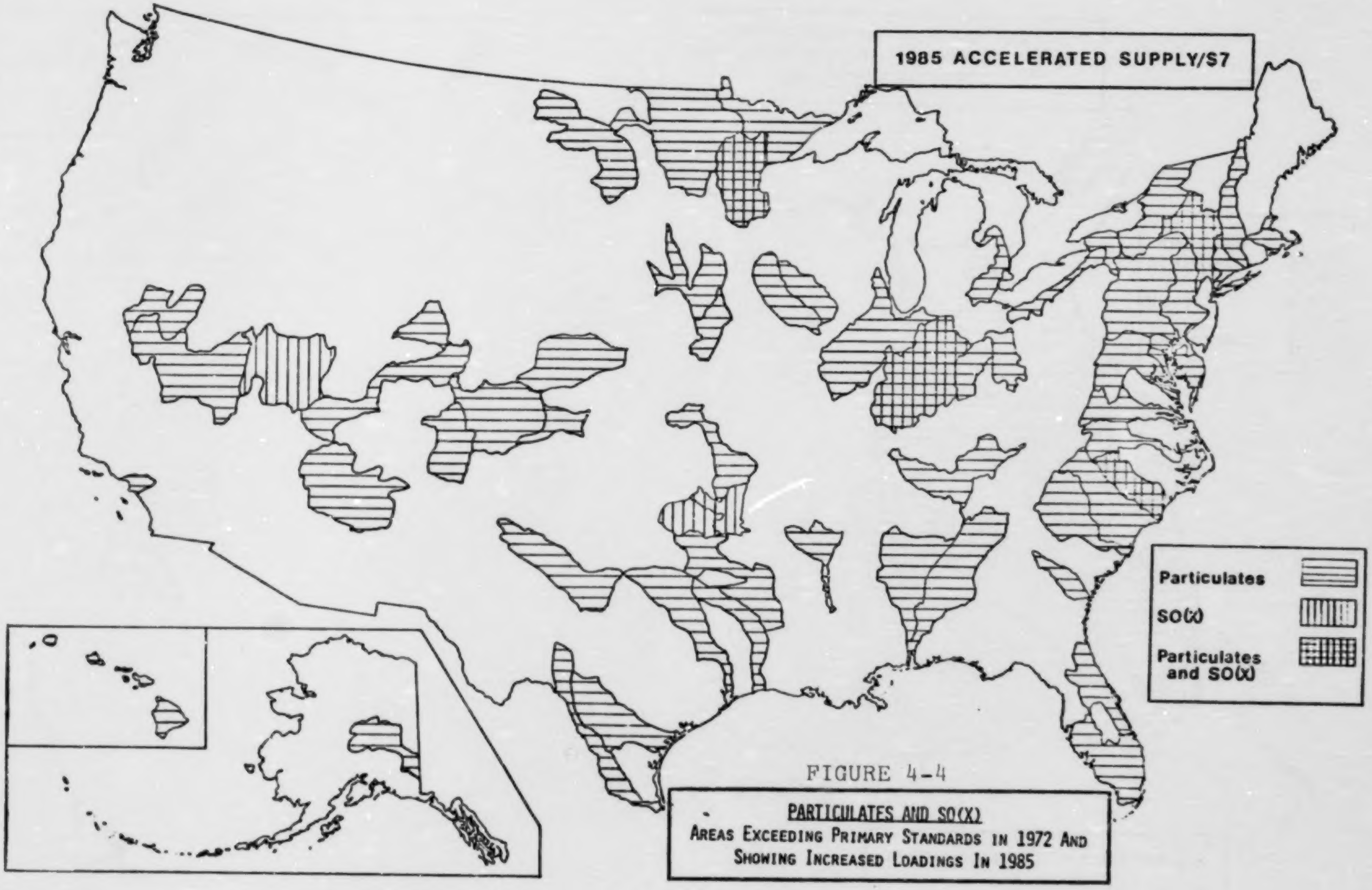

1985 ACCELERATED SUPPLY/S7
Particulates
SO(X)
Particulates and SO(X)

FIGURE 4-4

PARTICULATES AND SO(X)

AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

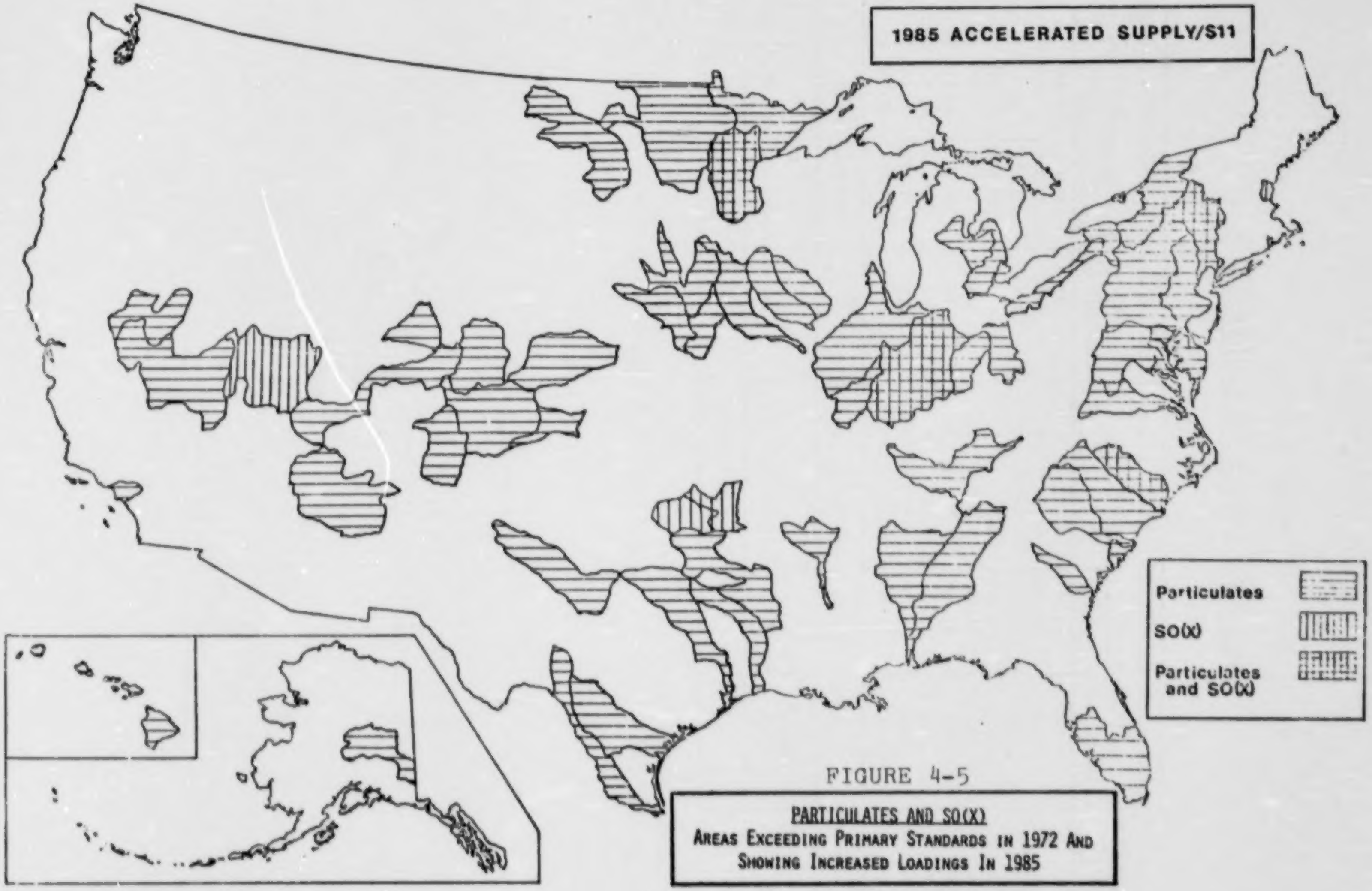

1985 ACCELERATED SUPPLY/S11
Particulates
SO(X)
Particulates and SO(X)

FIGURE 4-5

PARTICULATES AND SO(X)

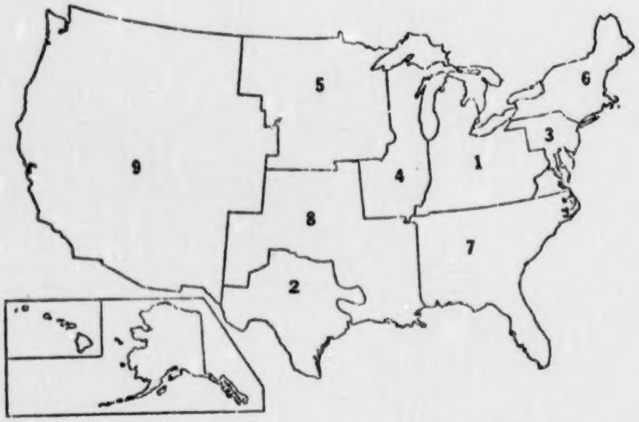
AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

TABLE 4-5

PREDICTED RADIATION LOADINGS[a]

NUCLEAR POWER PLANTS Electric Utility Region	BUSINESS AS USUAL				ACCELERATED SUPPLY			
	U-235 (tons/day)	MEDIUM			U-235 (tons/day)	MEDIUM		
		Air (curies/day)	Water (curies/day)	Solids (curies/day)		Air (curies/day)	Water (curies/day)	Solids (curies/day)
1	.066	79.988	19.079	0	.077	94.103	22.446	0
2	.024	29.086	6.938	0	.028	34.219	8.162	0
3	.077	94.531	22.548	0	.091	111.213	26.527	0
4	.066	79.988	19.079	0	.077	94.103	22.446	0
5	.012	14.543	3.468	0	.014	17.110	4.081	0
6	.072	87.259	20.814	0	.084	102.658	24.467	0
7	.185	225.42	53.768	0	.217	265.191	63.255	0
8	.030	36.358	8.672	0	.035	42.774	10.203	0
9	.066	79.988	19.079	0	.077	94.103	22.446	0
Total From Power Plants	Used .598	727.162	173.446	0	Used .70	855.476	204.052	0
Uranium Fuel Cycle Except Power Plants	Produced .598	177022.171	1203.989	290.269	Produced .701	208259.251	1416.443	341.489
National Total	-	177749.333	1377.435	290.269	-	209114.727	1620.495	341.489

[a] Radioactivity from the wastes of nuclear power plants stored in nuclear waste disposal facilities is not included.



ELECTRIC UTILITY REGIONS

TABLE 4-6

POLLUTION LOADINGS FROM URANIUM FUEL CYCLE
(Except Nuclear Power Plants)

POLLUTANTS	BUSINESS-AS-USUAL	ACCELERATED SUPPLY
Acids (tons/day)	0.000	0.000
Bases (tons/day)	0.000	0.000
TDS (100 tons/day)	0.494	0.581
SS (tons/day)	0.000	0.000
Organics (100 tons/day)	0.000	0.000
Thermal (E9 Btu/day)	0.000	0.000
Particulates (tons/day)	3.195	3.758
NO(x) (tons/day)	14.364	16.899
SO(x) (tons/day)	15.974	18,792
HC (tons/day)	1.222	1.437
CO (tons/day)	0.107	0.126
Aldehydes (tons/day)	0.383	0.451
Solids (1,000 tons/day)	48,398	56.938
Fixed Land (100 acres)	1,015.970	1,195.247
Max. In. Land (100 acres)	0.000	0.000

Both of these tasks are difficult and involve substantial subjective analysis. Possible approaches to the problem include rating pollution loadings by comparing them to environmental standards, but this requires a consistent set of standards for all pollutants, which are not available. Rating of regional importance should include some measures of population, area and existing air and water quality and land use. Since there is no consensus on these value judgements, this type of analysis was not included in the scope of the project.

Still, some comparative measure of the impacts of the scenarios is possible. The scope of the project limits the analysis to considering only the impacts from 15 pollutants in ten Demand Regions. The Demand Regions correspond exactly to the nine FEA Demand Regions except that here Alaska is considered as a separate Demand Region (10) instead of part of FEA Demand Region 9.

Further, the price for imported oil is taken to be an independent variable; either $7 or $11. Once the price for imported oil has been assigned, a comparison between the strategies of the impact of any pollutant on any Demand Region can be made objectively. Table 4-7 summarizes the results for the strategies at the $7 price of imported oil. The entries in the table indicate the strategy that has the lesser pollutant loading for a particular Demand Region. No entry is made when there is no significant difference between strategies.

In no region does the Accelerated Supply scenario show any significantly lower loading than the Business as Usual scenario at the $7 price for imported oil. Therefore, if the price for imported oil in 1985 is $7, then the Business as Usual strategy is preferable to Accelerated Supply with respect to the 15 pollutants considered. The reason for the dominance of the Business as Usual strategy is that on a national level almost every energy activity is less for BAU than AS. The only exceptions are gas-fired power generation which is only 1 percent higher for BAU, and hydroelectric power generation which is the same for both scenarios.

With the price for imported oil at $11, the decision is not as clear. Table 4-8 summarizes the comparison. Apparently the Accelerated Supply scenario is preferable to the Business as Usual scenario. However, the table shows that organics loadings, hydrocarbons and solids are higher under the Accelerated Supply scenario. This reflects more oil production, natural gas production and oil shale extraction,

TABLE 4-7

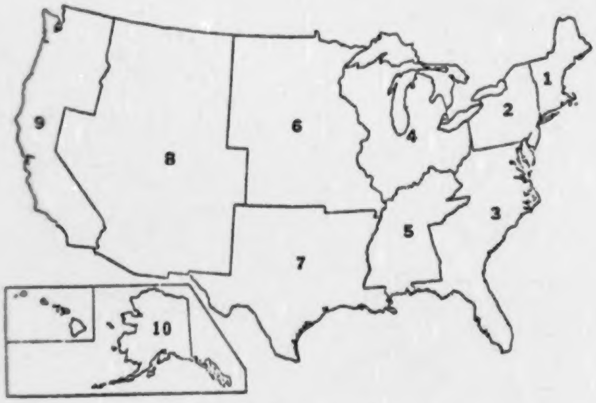
COMPARISON OF $7 SCENARIOS

POLLUTANT	DEMAND REGIONS 1	2	3	4	5	6	7	8	9	10	Nat.	TOTAL NO. (less Nat.) A	B	-
Acids	-	-	-	-	-	-	-	-	-	-	-	0	0	10
Bases	-	-	-	B	B	B	B	-	-	-	B	0	4	6
TDS	B	B	B	B	B	B	B	B	B	B	B	0	10	0
SS	-	-	-	B	B	B	B	B	B	B	B	0	7	3
Organics	B	-	B	B	-	B	B	B	B	B	B	0	8	2
Thermal	B	B	B	B	B	B	B	B	B	-	B	0	9	1
Part.	-	B	B	B	-	B	B	B	B	B	B	0	8	2
NO_X	-	B	B	B	-	B	B	B	B	B	B	0	8	2
SO_X	B	B	B	B	-	B	B	B	B	B	B	0	9	1
HC	B	B	B	B	B	B	B	B	B	B	B	0	10	0
CO	B	B	B	B	B	B	-	B	B	B	B	0	9	1
Ald.	-	B	B	B	B	-	B	B	B	B	B	0	8	2
Solids	B	B	B	B	B	B	B	B	B	B	B	0	10	0
F-Land	B	B	B	B	B	B	B	B	B	B	B	0	10	0
I-Land	-	-	-	B	B	B	B	B	-	-	B	0	5	5
TOTAL NO.														
A	0	0	0	0	0	0	0	0	0	0	0	0		
B	8	10	11	14	10	13	13	13	12	11	14		115	
-	7	5	4	1	5	2	2	2	3	4	1			35

A = Accelerated Supply has less loading

B = Business as Usual has less loading

- = if difference between strategies is less than 5% or if difference between strategies is less than 1% of the National total of that pollutant in Business as Usual



DEMAND REGIONS

TABLE 4-8

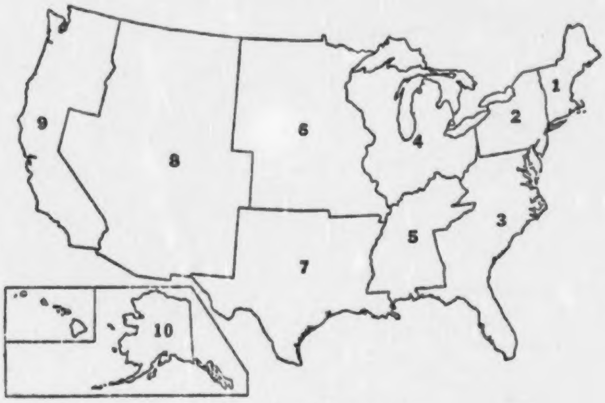
COMPARISON OF $11 SCENARIOS

	DEMAND REGIONS											TOTAL NO. (less Nat.)		
POLLUTANT	1	2	3	4	5	6	7	8	9	10	Nat.	A	B	-
Acids	-	-	-	-	-	-	-	-	-	-	-	0	0	10
Bases	-	-	A	A	A	-	-	-	-	-	A	3	0	7
TDS	-	-	A	A	-	-	B	A	B	-	A	3	2	5
SS	-	-	A	A	A	-	B	-	-	-	A	3	1	6
Organics	B	-	B	-	-	-	B	-	B	B	B	0	5	5
Thermal	-	-	-	-	A	-	-	-	-	-	-	1	0	9
Part.	-	-	A	-	A	-	-	-	-	-	-	2	0	8
NO_X	-	A	A	A	A	-	-	-	-	-	A	4	0	6
SO_X	-	-	A	A	A	-	A	-	-	-	A	4	0	6
HC	-	-	A	-	-	-	B	-	B	-	B	1	2	7
CO	A	A	A	A	A	-	A	-	-	-	A	6	0	4
Ald.	-	-	A	A	-	-	B	A	B	-	-	3	2	5
Solids	A	A	A	-	A	-	-	B	-	-	B	4	1	5
F-Land	-	-	-	-	-	-	-	-	-	-	-	0	0	10
I-Land	-	-	A	A	A	A	A	-	-	-	A	5	0	5
TOTAL NO.														
A	2	3	11	8	9	1	3	2	0	0	7	39		
B	1	0	1	0	0	0	5	1	4	1	3		13	
-	12	12	3	7	6	14	7	12	11	14	5			98

A = Accelerated Supply has less loading

B = Business as Usual has less loading

- = if difference between strategies is less than 5% or if difference between strategies is less than 1% of the National total of that pollutant in Business as Usual



DEMAND REGIONS

respectively, in that scenario. Similarly, Demand Regions 7, 9 and 10 appear to be more adversely affected under the AS than under BAU because of larger refinery production in Regions 7 and 9 and larger oil production in Region 10 under AS. Although Table 4-8 indicates that two pollutants are favored in AS and only one in BAU for Demand Region 8, this region probably would suffer more under AS than BAU. The differences between scenarios of total dissolved solids and aldehyde loadings in Demand Region 8 are quite small and probably less important than the difference in solids loadings.

Therefore, a large significance attached to one or more of the following might lead to a preference for the Business as Usual scenario:

1. Organics
2. Hydrocarbons
3. Solids
4. Some portions of the western part of the United States

Otherwise, the Accelerated Supply scenario is the more desirable. However, Table 4-8 shows that in only 52 of a possible 150 cases is there a significant difference between the scenarios. This indicates that in most cases under the $11 price for imported oil the choice of strategy is not important.

A comparison of the national pollution loadings at $7 versus $11 per barrel of imported oil shows the following:

- All loadings except thermal, particulates and aldehydes are lower at $7 per barrel for imported oil than at $11 per barrel;
- Particulate loadings are less under BAU $7 than BAU $11, but more under AS $7 than AS $11;
- Thermal and aldehyde loadings are less at $11 per barrel of imported oil than $7 per barrel.

At $7 per barrel of imported oil there is more oil consumption (but less domestic oil production) than at $11 per barrel. This means that at $7 per barrel of imported oil there is more oil-fired power generation, less coal production and less coal-fired power generation than at $11 per barrel. Conversely, at $11 per barrel of imported oil there is more coal production, more coal-fired power generation and less oil-fired power generation. Thus, loadings are less at $7 per barrel of oil than at $11 per barrel for those pollutants that are more affected by changes in coal production, oil production or coal-fired power generation than by oil-fired power generation. This includes all pollutants except thermal, particulates and aldehydes. Conversely, loadings are less at $11 per barrel for those pollutants that are more affected by oil-fired power generation -- this includes thermal, particulates and aldehydes. Particulates loadings are not very sensitive to price levels.

Although there is less domestic oil production at $7 per barrel of imported oil than at $11 per barrel, there is greater refining of imported crude oil at $7. Thus, total domestic refinery production is slightly higher at $7 than at $11 per barrel.

Since the geographic distribution of energy activities differs among regions, some regions may experience variations from the national loading trends discussed above for some pollutants. These variations are due to regional allocations of coal and oil activities not in the same proportions as the national allocations.

4.5 Effect of Control Technology

In order to test the sensitivity of assumptions regarding control technology, the 1972 pollution loading coefficients were applied to the 1985 Accelerated Supply $11 per barrel of imported oil scenario. Production from oil shale, coal gasification and coal liquefaction were eliminated from the 1985 scenario since there was no significant synthetics production in 1972. The results show that one of the central issues in developing a national energy policy is the degree of control technology requirements (See Table 4-9).

Significantly, application of the control technology requirements of surface mine reclamation legislation not only ameliorates land impacts, but also substantially reduces loadings of acids, total dissolved solids and suspended solids.

If no further improvement is made in control technology applications before 1985, regional pollution loadings will increase in proportion to the regional increases in the energy activities producing the pollutant. National loadings may not increase proportionally because of differences among the regions.

TABLE 4-9

EFFECT OF CONTROL TECHNOLOGY[a]

WATER POLLUTANTS

	ACIDS (tons/day)	BASES [b] (tons/day)	TDS (100 tons/day)	SS (tons/day)	ORGANICS (100 tons/day)	THERMAL [c] (E9 Btu/day)
AS/$11 with 1972 Control Technology	1,453	23.30	531.5	14,389	5.97	35,304
AS/$11 with Advanced Control Technology	0	36.67	54.4	265	1.84	24,021
Major Regulated Activities [d]	Coal mining	Coal mining	Surface coal mining	Coal mining	Oil refining Oil production Coal power generation	Electricity generation

AIR POLLUTANTS

	PARTICULATES (tons/day)	NO(X) (tons/day)	SO(X) (tons/day)	HC (tons/day)	CO (tons/day)	ALDEHYDES (tons/day)
AS/$11 with 1972 Control Technology	3,049	42,525	100,369	29,942	9,704.6	394.52
AS/$11 with Advanced Control Technology	2,056	33,622	48,317	20,379	1,169.5	391.13
Major Regulated Activities	Coal power generation Oil refining	Fossil fuel power generation	Coal power generation Oil refining	Oil refining	Oil refining Coal power generation	

LAND USE

	SOLIDS (1000 tons/day)	FIXED LAND (100 acres)	MAX. INCREMENTAL LAND (100 acres)
AS/$11 with 1972 Control Technology	1,692.9	367,551	23,910
AS/$11 with Advanced Control Technology	541.2	356,210	21,460
Major Regulated Activities	Surface coal mining		Surface coal mining

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[a] Loadings are for the same amount, type and location of energy activities. In this case the 1985 AS $11 scenario was used.

[b] Effective control of acids from coal mining assumed for advanced technology is accomplished through neutralization with bases.

[c] E9 is 1,000,000,000.

[d] Activity whose regulation causes major loading reduction.

4.6 Energy Development and Threatened Wildlife An Impact Analysis

In addition to pollution loadings, another aspect of the environmental impacts of energy development is modification or disruption of ecosystems. A complete analysis of ecosystem impacts involves a massive effort in data collection and modelling. Such an effort is well beyond the scope of this project. However, as an additional indicator of the ecological impacts of the different FEA scenarios, beyond pollution loadings, a preliminary analysis of the potential impacts on threatened wildlife was undertaken. This chapter presents the results of that analysis.

Although this report focuses on the rare and endangered species of the United States, these species are not isolated from the integrated biotic community. Energy development will have an impact on all species, flora and fauna, and its impact on the more common forms of wildlife should not be ignored. Among the ways in which energy development will impact ecosystems are:

- Destruction of habitat or interruption of territories;
- Introduction of toxic or lethal pollutants;
- Breaking of food chains through local elimination of a species; and
- Greater pressures by man including hunting and energy-related secondary development.

The species herein, identified by the Bureau of Sport Fisheries and Wildlife, are at present particularly vulnerable to extinction because of their limited numbers and loss of habitat. New energy development could cause further danger to these species by the disruption of habitat, increased pollution, or even by the mere presence of man in presently undisturbed areas.

There are several schools of thought regarding the importance of preventing the extinction of rare and endangered species. Some experts contend that the primary value of rare and endangered species lies in their contribution to the world gene pool. They maintain that if major environmental changes occur in the future, species that are marginally successful today may be ideally suited for new niches. Thus the extinction of these species reduces the total adaptive potential of the biosphere, rendering it less stable over time.

Other experts argue that if present species variety is decreased by extinction of rare and endangered species, the potential for stability of the world's existing ecosystems will be reduced. They feel it is important to insure the survival of existing species in order to maintain present ecosystem stability. Indeed, threatened species can be as important as the ecosystem's dominant species in assuring the maintenance of stability, complexity, and trophic structure of any given biotic community.

In contrast, some people argue that the concern for threatened species is unwarranted. They believe that these species are disappearing due to natural evolutionary forces which are beyond man's ability to control.

Several endangered species, such as the black-footed ferret, play important roles in controlling the populations of their prey, such as rodents and rabbits. Other species are considered valuable because of their unique biological functions, like the Texas blind salamander or the various species of endangered bats. Many other endangered animals simply provide joy to the beholder.

In addition, specific rare species are important members of species-species interactions in which the other species is common in the ecosystem. The rare species induces the stability of the other species population. Elimination of the controlling rare species will cause population fluctuations of other species, even if overall ecosystem stability is not destroyed. This especially applies to the highest trophic level: birds of prey and other large predators.

The focus on rare and endangered species stems from the concern which the Federal government has expressed for these animals. Reflecting this, there are several Federal and state laws protecting many endangered animals. These include the Migratory Bird Treaty Act (16 U.S.C. 703-711), the Bald Eagle Act (16 U.S.C. 668-668d), and the Marine Mammal Protection Act (P.L. 92-522). Because of the small numbers and limited habitat of most endangered species, in many cases only very specific efforts to avoid adverse environmental impacts are required. Hopefully, this report will facilitate such efforts by identifying the potential threats to rare and endangered species posed by energy development.

The following table and list of threatened species which may be impacted by energy development were taken from Threatened Wildlife of the United States, 1973 Edition, U.S. Department of the Interior. It was supplemented by several interviews with Wildlife biologists.

Table 4-10 presents a summary of the information in the subsequent list. In the table "sensitivity to man" refers to disruption of territories, noise, disruptions of habitat or, even, the presence of humans.

The table and list are not comprehensive since only a few sources were used in their preparation. Further research is necessary for a definitive analysis. Only those species indicated with an asterisk are officially designated as endangered with extinction by the Secretary of the Interior.

List of Threatened Wildlife Which May Be Impacted by Energy Development

Demand Region 1:

Fish:

Sunapee Trout (Salvelinus auredlus)

Found only in Flood's Pond, Hancock County, Maine. Siting of energy facilities should avoid this area.

Demand Region 2:

Reptiles and Amphibians:

Bog Turtle (Clemmys muhlenbergi)

Found in isolated colonies from Connecticut to North Carolina, in fresh water marshes, meadows, and bogs. Siting of energy facilities should avoid these colonies.

TABLE 4-10

POSSIBLE IMPACT OF ENERGY DEVELOPMENT ON THREATENED SPECIES

NOTE: "XXX" INDICATES PERIPHERAL RANGE OR HABITAT

HABITAT:

SPECIES	LAKE	RIVER	FOREST	TUNDRA	COASTAL SCRUB/BEACH	ESTUARY/MARINE	PRAIRIE	MOUNTAIN	WETLAND (MARSHES, BOGS)	CAVES/UNDERGROUND	SENSITIVITY TO MAN
DEMAND REGION 1: Sunapee Trout	Siltation or water quality degradation. Competition from changes in species populations.										
DEMAND REGION 2: Bog Turtle									Degradation of water quality. Destruction of habitat from construction of facilities		
DEMAND REGION 3: Roanoke Bass	Siltation or water quality degradation. Competition from changes in species populations.										
American Alligator	XXX	XXX				Destruction of habitat from construction of facilities. Threats from oil spills.			XXX		
Bachman's Warbler		XXX							Destruction of habitat from construction of facilities.		
Eastern Brown Pelican						Threat from oil spills.					
Southern Bald Eagle						Destruction of habitat from construction of facilities.					XXX
Virginia Big-eared Bat										Destruction of habitat from underground coal facilities.	XXX
DEMAND REGION 4: Northern Greater Prairie Chicken							Destruction of habitat from construction of facilities and surface coal mining.				
Indiana Bat										Destruction of habitat from underground coal facilities.	
DEMAND REGION 5: American Alligator	XXX	XXX				XXX See Demand Region 3			XXX		
Southern Bald Eagle						XXX See Demand Region 3					XXX
Eastern Brown Pelican						XXX See Demand Region 3					
Ivory-billed Woodpecker			Destruction of habitat from construction of facilities.								
DEMAND REGION 6:	No energy development impacts on threatened wildlife identified in this demand region										
DEMAND REGION 7: American Alligator	XXX	XXX				XXX See Demand Region 3			XXX		
Texas Blind Salamander										Degradation of groundwater quality or lowering of water table.	
Houston Toad			Destruction of habitat from surface coal mining and electrical generation								

TABLE 4-10 (CONT.)

POSSIBLE IMPACT OF ENERGY DEVELOPMENT ON THREATENED SPECIES

	HABITAT:										
SPECIES	LAKE	RIVER	FOREST	TUNDRA	COASTAL SCRUB/BEACH	ESTUARY/MARINE	PRAIRIE	MOUNTAIN	WETLAND (MARSHES, BOGS)	CAVES/UNDERGROUND	SENSITIVITY TO CAA
Western Brown Pelican						XXX See Demand Region 3					
Ivory-billed Woodpecker			XXX See Demand Region 5								
Whooping Crane						Threats from oil spills.					
Attwater's Greater Prairie Chicken							Destruction of habitat from construction of facilities and surface coal mining.				
Golden-cheeked Warbler			Destruction of habitat from surface coal mining and electrical generation								
Red Wolf									Destruction of habitat from construction of facilities.		XXX
DEMAND REGION 6:											
Arctic Greyling	Siltation or water quality degradation; interference with migration.										
Humpback Chub Colorado Squawfish Kendall's Warm Springs Dace		Siltation or degradation of water quality.									
American Peregrine Falcon		XXX	Destruction of habitat from construction of facilities and surface coal mining.					XXX			XXX
Prairie Falcon							Destruction of habitat from construction of facilities and surface coal mining.				XXX
Tule White-fronted Goose									Destruction of habitat used during migration from construction of energy facilities.		
Black-footed Ferret							Destruction of habitat from construction of facilities and surface coal mining.				
Spotted Bat										Destruction of habitat from oil shale and surface mining operations.	

TABLE 4-10 (CONT.)

POSSIBLE IMPACT OF ENERGY DEVELOPMENT ON THREATENED SPECIES

SPECIES	HABITAT: LAKE	RIVER	FOREST	TUNDRA	COASTAL SCRUB/BEACH	ESTUARY/MARINE	PRAIRIE	MOUNTAIN	WETLAND (MARSHES, BOGS)	CAVES/UNDERGROUND	SENSITIVITY TO MAN
Grizzly Bear		XXX	XXX					Pressure and reduction of habitat requirement from construction of facilities.			XXX
BEYOND REGION 9: American Peregrine Falcon		XXX	XXX See Beyond Region 8					XXX			XXX
California Clapper Rail						Threat from oil spills. Destruction of habitat from construction of facilities.					
Light-footed Clapper Rail						Threat from oil spills. Destruction of habitat from construction of facilities.					
California Brown Pelican						Threat from oil spills.					
California Least Tern					Nesting habitat threatened by construction of facilities	Threat from oil spills.					
Spotted Owl				Destruction of habitat from surface coal mining and construction of facilities.							XXX
Morro Bay Kangaroo Rat					Destruction of habitat from construction of facilities.						
Southern Sea Otter						Threats from oil spills					
BEYOND REGION 10: Aleutian Canada Goose						Threats from oil spills.					
American Peregrine Falcon		XXX	XXX See Beyond Region 8								XXX
Arctic Peregrine Falcon				Destruction of habitat from construction of facilities and oil production.							XXX
Grizzly Bear		XXX	XXX					XXX See Beyond Region 8			XXX
Glacier Bear		XXX		XXX				Pressure and reduction of habitat requirements from construction of facilities.			XXX
Ribbon Seal						Threat from oil spills.					

Demand Region 3:

Fish:

Roanoke Bass (Ambloplites cauifrons)

Found in the Upper Tar and Neuse Rivers in North Carolina and possibly in the upper Roanoke River in Virginia. Protection of swift, rocky rapids habitat is essential to the survival of the fish.

Reptiles and Amphibians:

*American Alligator (Alligator mississippiensis)

Found on the Atlantic Coastal Plain from North Carolina to Texas. Habitat destruction should be avoided. Alligators, as with all reptiles, take water in through their skins. Thus oil spills or other types of water pollution may cause irritation or more serious manifestations.

Birds:

*Bachman's Warbler (Vermiuora bachmanii)

This very rare species sighted infrequently in Virginia, South Carolina, and Alabama. It breeds in river swamp forests. Protection of virgin river, swamps or bottomland timber is necessary for the species survival.

*Eastern Brown Pelican (Pelicanus occidentalis carolinensis)

Breeds on the Atlantic and Gulf Coasts. This species dives for fish and would be threatened with coating by oil during oil spills. A thin layer of oil on the surface may be clear enough to avoid detection by hunting birds. Oil coated vegetation used in nest building poses a threat to this species.

*Southern Bald Eagle (Haliatetus leucocephalus leucolephalus)

Nests is estuarine regions of the Atlantic and Gulf Coasts. Threatened by loss of habitat and by pressure from development.

Mammals:

Virginia Big-eared Bat (*Plecotus townsendii virginianus*)

This cave-dwelling species lives in colonies in and around Pendleton County, West Virginia. It is also found in Tazewell County, Virginia, and Lee County, Kentucky. The latter two counties contain deposits of coal, while the former borders a major coal region. As the species is intolerant of human disturbance, care must be taken to avoid mining or related activities near colonized caves.

Demand Region 4:

Birds:

Northern Greater Prairie Chicken (*Tympanuchus cupido pinnatus*)

Found locally in prairie and grassland areas in northwest Indiana and south central Illinois (also north to North Dakota and Minnesota, west to Colorado and east to Oklahoma and Michigan). Preservation of natural prairie and grassland must be identified and avoided in siting strip mines and related operations.

Mammals:

*Indiana Bat (*Myotis sodalis*)

Found from Oklahoma to Vermont, and from Wisconsin to Florida. Inhabits major limestone areas which should be avoided by mining and related operations.

Demand Region 5:

Reptiles and Amphibians:

*American Alligator

(see Demand Region 3 for information)

Birds:

*Southern Bald Eagle

(see Demand Region 3 for information)

*Eastern Brown Pelican

(see Demand Region 3 for information)

*Ivory-billed Woodpecker (Camphehilus p. principalis)

Extremely rare, perhaps extinct; habitat in southern Texas, southern Louisiana, and central South Carolina. Survival of this species depends on the preservation of scattered mature bottom land hardwood forests, containing dead and dying trees which supply the wood-boring beetle larvae required for food.

Demand Region 6:

No endangered species identified as threatened by energy development in this region.

Demand Region 7:

Reptiles and Amphibians:

*American Alligator

(see Demand Region 3 for information)

*Texas Blind Salamander (Typhomolge rathbuni)

Found in deep wells and aquifers in Hays County, Texas. Reduction in groundwater quality or change in water levels from lignite mining or electricity generation must be avoided to insure the survival of this species.

*Houston Toad (Bufo houstonensis)

Found in Bastrop County, Texas, and surrounding areas. This species is found in the heart of Texas lignite deposits. Strip mines and related development should be sited to avoid the destruction of breeding colonies and habitat of the Houston toad.

Birds:

*Eastern Brown Pelican

(see Demand Region 3 for information)

*Ivory-billed Woodpecker

(see Demand Region 5 for information)

*Whooping Crane (Grus americana)

Winters in the Aransas National Wildlife Refuge in Aransas County, Texas. This species is threatened by OCS and related development along the Gulf Coast. Direct contact with spilled oil can cause death from exposure. Use of oil coated vegetation for nest building could constitute a serious problem. Disruption of prey populations, such as frogs and crabs, is also a hazard to this extremely endangered species.

*Attwater's Greater Prairie Chicken (Tynpanuchus cupido attwateri)

Found only in the Attwater Prairie Chicken Preserve in Colorado County, Texas. This species could be threatened by pressure and pollution from lignite coal development in counties immediately upstream.

Golden-cheeked Warbler (Dendroica chrysopaxia)

Found in northeastern Texas. This species lives only in cedar breaks in this area. Care must be taken to insure that any lignite development near these cedar breaks does not threaten survival.

Mammals:

*Red Wolf (Canis rufus)

Pure population found in southeastern Texas and Louisiana along the Gulf of Mexico. The red wolf is threatened by pressure from proximity to development. Because of the Red Wolf's large range requirements, OCS-related on-shore development and new coal mining activities should be planned to reserve large tracts of suitable habitat.

Demand Region 8:

Fish:

Arctic Greyling (Thymallus arcticus)

Found in a few lakes in Montana, Utah, Wyoming, Colorado, and Washington. This species is threatened by the destruction of habitat. The threats include siltation on spawning grounds, interference with spawning migrations from impoundments, and warming of water from thermal pollution.

*Humpback Chub (Gila cypha)

*Colorado Squawfish (Ptychocheilus lucius)

*Kendall's Warm Springs Dace (Rhinichthys osculus thermalis)

These fish species are found in the Green and Colorado Rivers. They are threatened by the possible degradation of water quality in these river basins.

Birds:

*American Peregrine Falcon (Falco peregrinus anatum)

Found from Alaska and Canada to the Mexican border. Destruction of breeding sites and interference with migration are possible results of energy development. Falcon breeding areas should be protected.

*Prairie Falcon (Falco mexicanus)

Found throughout the West from the Canadian border to northern Arizona and Texas. Little is known about this species.

Tule White-fronted Goose (Anser albifrons gambelli)

Found in the Northern Great Plains region during migration. Stopover areas on its flyway should be identified and protected.

Mammals:

Prairie Dog (Cynomys gunnisoni) and (Cynomys ludovicianus)

Although itself not endangered, these species serve as a vital food source for many higher order species such as the black-footed ferret, an endangered species. Reduction of prairie dog populations would threaten its predators. Strip mining and related development could disrupt prairie dog habitat.

*Black-footed Ferret (Mustela nigripes)

Found from western North and South Dakota to northern Montana, south to Texas. The survival of this species is dependent on the vitality of prairie dog colonies.

Spotted Bat (Euderma maculatum)

Found in the Southwest and as far north as southern Montana and Idaho and as far east as Brewster County, Texas. This species lives in cliffs and canyon walls.

Grizzly Bear (Ursus arctus horribilis)

Found in Colorado, Idaho, Wyoming, Montana, and Washington. This species is very intolerant of human activity. Energy related development such as transmission lines and roads should avoid interference with grizzly bear range requirements.

Demand Region 9:

Birds:

*American Peregrine Falcon

(see Demand Region 8 for discussion)

*California Clapper Rail (Rallus longirostris obsoletus)

Found in several coastal bays from San Francisco south to Morro Bay. This rail is threatened by oil spills or chronic oil pollution from OCS onshore and refinery development. Also, oil pollution can destroy the rail's habitat by killing marsh vegetation or by altering food populations.

*Light-footed Clapper Rail (Rallus longirostris levipes)

Found in the Salicornia marshes from Santa Barbara County to the Mexican border. This species is threatened by the same factors as the California Clapper Rail.

*California Brown Pelican (Pelicanus occidentalis)

Found along the southern coast of California and the islands off the coast. This species, like the

Eastern Brown Pelican, is threatened by certain oil spills because it dives for fish and can become contaminated by oil. Use of oil-coated vegetation for nest building poses an additional hazard.

*California Least Tern (Sterna albifrons browni)

Found along the Pacific coast from San Francisco Bay to southern Baja California. This tern faces three major threats from OCS and refinery development. It is a diving bird and therefore can be coated by spilled oil. Also, the tern breeds on sandy beaches which are often covered by spilled oil washed up by wave action. Finally, valuable beach breeding habitat could be destroyed by refining and pipeline construction.

*Spotted Owl (Stirix occidentalis)

Found along the Pacific coast from Canada south to California. This species is threatened by coal development in coastal Washington. Strip mining and related development will result in additional destruction of old-growth timber, the habitat of the spotted owl. As the birds have been found unable to relocate in new areas, development should be prevented in spotted owl areas.

Mammals:

Morro Bay Kangaroo Rat (Dipodomys heermanni morroensis)

Found only on the southern side of Morro Bay, San Luis Obispo County, California. The siting of refineries and pipelines should avoid the 1.7 square mile site where this species is found.

Southern Sea Otter (Enhydra lutis nereis)

Found along the Pacific Coast from Washington to Baja California. This species is threatened by OCS development because oil spills could disrupt its food supplies. Spilled oil poses an additional threat because coating by oil destroys the insulation and buoyancy provided by the otter's hair, resulting in either drowning or freezing.

Whales (Cetacea)

Cetologists assume that whales are intelligent and mobile enough to avoid offshore oil production facilities and oil spills. However, further research is needed, particularly concerning the impact of oil pollution on whale breeding areas which may be threatened by oil spills. For example, the Gray Whale migrates from the Arctic to breed in a special lagoon in Baja California. Disruption of the migratory route or the lagoon could seriously threaten this species.

Demand Region 10:

Birds:

*Aleutian Canada Goose (*Branta canadensis leucopareia*)

Breeds in the Aleutian Islands. This species may be threatened by OCS development off the coast of Alaska if spilled oil is carried by currents to its breeding grounds.

*American Peregrine Falcon

(see Demand Region 8 for discussion)

*Arctic Peregrine Falcon (*Falco peregrinus tundrius*)

Found in the treeless tundra of far northern Alaska. Increased activity (such as exploratory drilling and pipeline and road building) should avoid falcon breeding areas.

Mammals:

Grizzly bear

(see Demand Region 8 for discussion)
In addition, in Alaska the grizzly feeds primarily on salmon and other anadromous fish. A widespread degradation of water quality or major spills at the mouths of certain rivers could pose a serious threat to the grizzly's food supply.

Glacier Bear (*Ursus americanus emmonsii*)

Found from the Upper Copper River and Matanucka River Valleys southwestward to the mouth of the Chickamin River. This species faces the same threats as the grizzly bear.

Ribbon Seal (Histriophoca fasciata)

Found on the western Alaskan coast from Point Barrow to the Aleutian Islands. Little is known about this species, and car should be taken with development occurring near ribbon seal areas.

CHAPTER FIVE

MANDATORY OIL IMPORT PROGRAM

5.1 Description of Scenarios

FEA provided Environment Reports and PIES Model Reports on Modifications to the Mandatory Oil Import Program of 21 January 1975 for the following scenarios:

- BC -- Base Case -- $7 for imported oil (FEA #85 ACC4A, DO7RM, E70RM, I7MOD7)
- IF -- Import Fee Case -- $7 for imported oil plus $2 fee (FEA #85 ACC4A, D07RM, E70RM, I7MOD6)

FEA's underlying assumptions for the Base Case were:

- $7/barrel price for imported oil;
- Accelerated development of domestic oil and gas;
- No nuclear development; and
- No other government policies.

The Import Fee Case differs from the Base Case only in that a $2 average fee is placed on each barrel of imported oil. The fee lowers the levels of imported oil which in turn requires higher levels of domestic energy production and induces a shift from oil to coal activities.

The 1972 scenario reflecting 1972 levels of activity was also included for comparison.

5.2 Major Energy Features

At the national level, energy production activities are very similar for each scenario. As a result, there is little difference in total pollution loadings between the scenarios. Production levels are shown in Table 5-1, and a more detailed analysis is in Table 5-2. The major differences in energy activities are:

- The Import Fee scenario shows more domestic production of fuels, including 20 percent more underground coal production and 6 percent more oil production, than the Base Case scenario.

TABLE 5-1

NATIONAL ENERGY PRODUCTION UNDER DIFFERENT FEA SCENARIOS

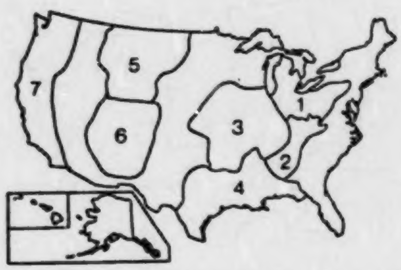
	1972	BASE CASE	IMPORT FEE	DIFFERENCE IF OVER BC	PERCENT DIFFERENCE	UNITS[a]
Surface Coal	753.887	1663.44	1690.66	27.2187	1.6	(E3 tons/day)
Underground Coal	876.791	872.111	1045.11	172.995	19.8	(E3 tons/day)
Natural Gas	72208.1	50425.9	51336.2	910.309	1.8	(E6 Scf/day)
Oil	9224.29	12542.	13265.3	723.3	5.7	(E3 bbls/day)
Hi Btu Gasification	0	0	0	0	0	(E6 Scf/day)
Coal Liquefaction	0	0	0	0	0	(E3 bbls/day)
Lo Btu Gasification	0	0	0	0	0	(E6 Scf/day)
Oil Shale	0	250	250	0	0	(E3 bbls/day)
Power Plants						
Coal-Fired	914.485	1799.57	2017.83	218.257	12.1	(E3 tons/day)
Oil-Fired	1204.07	3354.37	2593.51	-760.861	-22.7	(E3 bbls/day)
Gas-Fired	9354.12	7054.75	7054.75	0	0	(E6 Scf/day)
Turbines	0	0	0	0	0	(E3 bbls/day)
Nuclear	0.3433	0.598	0.598	0	0	(tons U-235/day)
Hydroelectric	77.3212	195.094	195.094	0	0	(E3 MW)
Refineries	13853	20066.5	18739.8	-1326.67	-6.6	(E3 bbls/day)

[a] Definitions:
E3 is 1,000
E6 is 1,000,000
bbl is a barrel or 42 gallons
MW is one million watts
Scf is a cubic foot at standard temperature and pressure

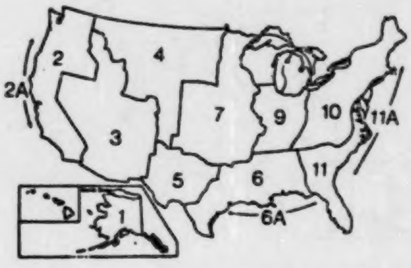
TABLE 5-2

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

RESOURCE ACTIVITY	1985 BASE CASE vs. 1972	1985 IMPORT TARIFF vs. 1972
ALL COAL PRODUCTION	NATIONAL: 55.5% increase to 2,536,299 tons per day	NATIONAL: 67.8% increase to 2,736,918 tons per day
UNDERGROUND COAL PRODUCTION	NATIONAL: .4% decrease to 872,837 tons per day Major Regional Aspects 1) COAL SUPPLY REGION 3 - 180% increase to 406,320 tons per day 2) COAL SUPPLY REGION 5 - 571.1% increase to 8,214 tons per day 3) COAL SUPPLY REGION 1 - 44.5% decrease to 172,491 tons per day 4) COAL SUPPLY REGION 2 - 31.1% decrease to 272,119 tons per day 5) COAL SUPPLY REGION 6 - 43.5% decrease to 13,690 tons per day	NATIONAL: 19.3% increase to 1,046,234 tons per day Major Regional Aspects 1) COAL SUPPLY REGION 3 - 318.7% increase to 607,388 tons per day 2) COAL SUPPLY REGION 5 - 557.1% increase to 8,214 tons per day 3) COAL SUPPLY REGION 1 - Same as for Base Case 4) COAL SUPPLY REGION 2 - 38.1% decrease to 244,448 tons per day 5) COAL SUPPLY REGION 6 - Same as for Base Case
SURFACE COAL PRODUCTION	NATIONAL: 120.6% increase to 1,633,462 tons per day Major Regional Aspects 1) Major increases in all regions except in Coal Supply Regions Six and Seven 2) Most substantial rise is in Coal Region 4, with a 697.1% increase to 88,480 tons per day	NATIONAL: 124.3% increase to 1,690,634 tons per day Major Regional Aspects 1) Same regional changes as for the Base Case, except increases are slightly greater
OIL PRODUCTION	NATIONAL: 35.4% increase to 12,543,900 barrels per day Major Regional Aspects 1) There are substantial decreases in all Petroleum Supply Regions except North Slope, 2A, and 11A 2) North Slope of Alaska - developed from a virgin area to 4,500,000 barrels per day 3) Petroleum Supply Region 2A - 1808.7% increase to 1,221,600 barrels per day 4) Petroleum Supply Region 11A - Developed from a virgin area to 490,300 barrels per day	NATIONAL: 43.2% increase to 13,267,200 barrels perday Major Regional Aspects 1) Same regional changes as for Base Case except for Petroleum Supply Region 1, which increases 292.2% to 781,900 barrels per day
OIL SHALE	NATIONAL: Developed to 250,000 barrels per day	NATIONAL: Identical to Base Case



COAL SUPPLY REGIONS

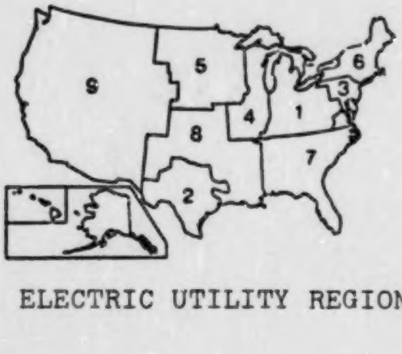


PETROLEUM SUPPLY REGIONS

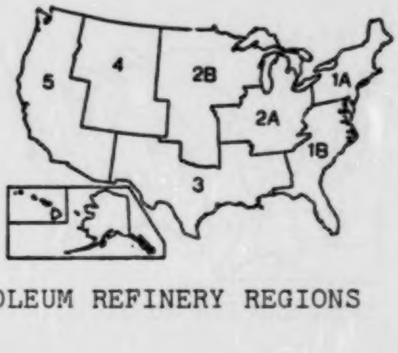
TABLE 5-2 (CONT.)

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

RESOURCE ACTIVITY	1985 BASE CASE vs. 1972	1985 IMPORT TARIFF vs. 1972
GAS PRODUCTION	NATIONAL: 29.9% decrease to 50,415.61 million SCF per day Major Regional Aspects 1) All Petroleum Supply Regions decline except Regions 2A, 9, 10, and 1A 2) Petroleum Supply Region 1 - decreases from 403.67 million SCF per day to zero 3) Petroleum Supply Region 2A - 91.6% increases to 104.21 million SCF per day 4) Petroleum Supply Regions 8, 9, 10 - 74.8% increase to 2240.15 million SCF per day 5) Petroleum Supply Region 11A is developed from a virgin area to 491.49 million SCF per day	NATIONAL: 28.7% decrease to 51,326.35 million SCF per day Major Regional Aspects 1) Same regional changes as for Base Case except Petroleum Supply Regions 3 and 6, which have slightly smaller decreases, and Petroleum Supply Regions 8, 9, and 10, which have slightly smaller increases
REFINERIES	NATIONAL: 44.2% increase to 20,066,475 barrels per day Major Regional Aspects 1) Slight increases in all PAD's except 1B, 2B, and 3. 2) PAD 1B increases 6777% to 6,945,833 barrels per day 3) PAD 2B decreases 73.5% to 398,422 barrels per day 4) PAD 3 decreases 5% to 5,269,000 barrels per day	NATIONAL: 35.2% increase to 18,739,817 barrels per day Major Regional Aspects 1) Same regional changes as for Base Case except for PAD 2A and 2B 2) PAD 2A decreases 85% to 324,444 barrels per day 3) PAD 2B increases 6.5% to 1,604,625 barrels per day
COAL FIRED. POWER PLANTS	NATIONAL: 104.7% increase to 1,789,145 tons pep day Major Regional Aspects 1) Substantial increases in all Electric Utility Regions 2) Electric Utility Region 2 - 2994% increase to 86,947 tons per day 3) Electric Utility Region 9 - 2916.5% increase to 37,246 tons per day	NATIONAL: 130.9% increase to 2,017,827 tons per day Major Regional Aspects Slightly higher increases from the Base Case for all Electric Utility Regions



ELECTRIC UTILITY REGIONS



PETROLEUM REFINERY REGIONS

TABLE 5-2 (CONT.)

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

RESOURCE ACTIVITY	1985 BASE CASE vs. 1972	1985 IMPORT TARIFF vs. 1972
OIL FIRED POWER PLANTS	NATIONAL: 193.8% increase to 3,354,369 barrels per day Major Regional Aspects 1) Substantial increases in all Electric Utility Regions 2) Electric Utility Region 1 - 845.4% increase to 714,217 barrels 3) Electric Utility Region 2 - from zero production in 1972 to 100,129 barrels per day 4) Electric Utility Region 5 - 1174.8% increase to 43,855 barrels per day 5) Electric Utility Region 8 - 1025.3% increase to 142,874 barrels per day	NATIONAL: 127.2% increase to 2,594,172 barrels per day Major Regional Aspects 1) Slightly lower increases in Electric Utility Regions 4, 7, and 9 than for the Base Case 2) Electric Utility Region 6 - 30.2% decrease to 304,220 barrels per day
NATURAL GAS FIRED POWER PLANTS	NATIONAL: 24.5% decrease to 7,060.225 million SCF per day Major Regional Aspects 1) Substantial decreases in Electric Utility Regions 4, 5, 6, 7, and 9 2) Electric Utility Region 2 - 80.8% increase to 3,154.329 million SCF per day 3) Electric Utility Region 3 - developed to 5.474 million SCF per day	NATIONAL: 24.5% decrease to 7,060.225 million SCF per day Major Regional Aspects Regional distribution is identical to Base Case
NUCLEAR POWER PLANTS	NATIONAL: 2414.7% increase to.596 tons U-235 Major Regional Aspects 1) Large increases in all Electric Utility Regions 2) Electric Utility Region 1 - increases 3782% 3) Electric Utility Region 7 - increases 6066% 4) Electric Utility Region 9 - increases 3566%	NATIONAL: 2414.7% increase to .596 tons U-235 Major Regional Aspects Regional distribution is identical to Base Case
HYDRO-ELECTRIC POWER PLANTS	NATIONAL: 152.3% increase to 195,111 megawatts Major Regional Aspects 1) Electric Utility Region 1 - 1379% increase to 9,765 mw capacity 2) Electric Utility Region 2 - 312% increase to 784 mw capacity 3) Electric Utility Region 3 - 507% increase to 4980 mw capacity	NATIONAL: 152.3% increase to 195,111 megawatts Major Regional Aspects Regional distribution is identical to Base Case

- The Import Fee scenario shows 12 percent more coal-fired electricity generation, 23 percent less oil-fired electricity generation, and 7 percent less oil refining than the Base Case.

5.3 Scenario Analysis

National and regional pollution loadings are summarized in Table 5-3. The differences in national pollution loadings between the scenarios reflect the production differences cited above. The most significant differences are:[1]

- Due to higher levels of oil production and refining, the Import Fee scenario shows 7 percent more organics loadings than the Base Case scenario.
- Due to lower levels of oil-fired electricity generation, the Import Fee scenario shows 4 percent less particulate loadings and 9 percent less aldehyde loadings than the Base Case scenario.
- Due to higher levels of coal-fired electricity generation, the Import Fee scenario shows 5 percent more carbon monoxide loadings and 7 percent more solids than the Base Case scenario.
- Due to higher levels of underground coal production and the resulting land subsidence, the Import Fee scenario shows 15 percent more incremental land use than the Base Case scenario.

Figures 5-1 and 5-2 show areas where primary standards for SO(X) and particulates were violated in 1972 and where there would be increased loadings in 1985. These areas are identical for each of the scenarios. This indicates that there is no significant difference between the two scenarios in the impact on the achievement of ambient air quality standards for these pollutants.

Major regional differences between the scenarios are summarized as follows (See Table 5-3):

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[1] A 7 percent difference in bases is insignificant due to the low absolute amount of base loadings.

TABLE 5-3

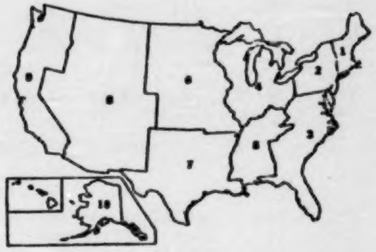
POLLUTION LOADINGS

ACIDS (tons/day)(Not including abandoned mines)

DR[a]	1972	BASE CASE	IMPORT FEE	IF-BC	PERCENT CHANGE
1	2.56	0.00	0.00	0.00	0.0
2	212.05	0.00	0.00	0.00	0.0
3	377.57	0.00	0.00	0.00	0.0
4	[illegible]	0.00	0.00	0.00	0.0
5	171.06	0.00	0.00	0.00	0.0
6	44.21	0.00	0.00	0.00	0.0
7	5.00	0.00	0.00	0.00	0.0
8	10.62	0.00	0.00	0.00	0.0
9	2.11	0.00	0.00	0.00	0.0
10	0.54	0.00	0.00	0.00	0.0
TOTAL	1096.7	0.00	0.00	0.00	0.0

SUSPENDED SOLIDS (tons/day)

DR[a]	1972	BASE CASE	IMPORT FEE	IF-BC	PERCENT CHANGE
1	2.4	0.0	0.0	0.0	0.0
2	1160.7	29.9	30.1	0.2	0.8
3	1740.2	115.1	110.1	-5.0	-4.3
4	1510.4	76.5	80.9	4.4	5.8
5	2695.4	63.7	64.9	1.2	1.8
6	55.2	10.3	12.5	2.3	22.2
7	231.0	20.3	20.5	0.2	1.0
8	82.3	2.6	2.6	-0.0	-0.1
9	100.6	9.3	8.8	-0.5	-5.4
10	2.7	0.3	0.3	-0.0	-3.8
TOTAL	7580.8	327.9	330.7	2.8	0.9



BASES (tons/day)

DR[a]	1972	BASE CASE	IMPORT FEE	IF-BC	PERCENT CHANGE
1	0.000	0.000	0.000	0.000	0.0
2	4.833	4.883	4.897	0.014	0.3
3	6.632	12.123	11.735	-0.388	-3.2
4	3.776	11.465	13.757	2.292	20.0
5	5.099	7.964	8.330	0.366	4.6
6	0.110	1.727	2.297	0.570	33.0
7	0.079	0.242	0.280	0.038	15.5
8	0.073	0.343	0.343	0.000	0.0
9	0.031	0.076	0.076	0.000	0.0
10	0.008	0.019	0.019	0.000	0.0
TOTAL	22.643	38.842	41.733	2.891	7.4

ORGANICS (100 tons/day)

DR[a]	1972	BASE CASE	IMPORT FEE	IF-BC	PERCENT CHANGE
1	0.003	0.047	0.046	-0.001	-1.9
2	0.303	0.050	0.048	-0.002	-3.8
3	0.268	0.245	0.236	-0.009	-3.8
4	0.566	0.120	0.090	-0.030	-25.2
5	0.205	0.065	0.060	-0.005	-7.7
6	0.205	0.058	0.056	-0.002	-2.7
7	1.464	0.642	0.642	0.000	0.0
8	0.179	0.090	0.093	0.003	3.1
9	0.491	0.377	0.374	-0.003	-0.7
10	0.017	0.148	0.331	0.183	123.5
TOTAL	3.701	1.843	1.977	0.134	7.3

[a]DEMAND REGION INDEX

1) North East
2) Mid-Atlantic
3) South-Atlantic
4) East North Central
5) East South Central
6) West North Central
7) West South Central
8) Mountain
9) Pacific
10) Alaska

TOTAL DISSOLVED SOLIDS (100 tons/day)

DR[a]	1972	BASE CASE	IMPORT FEE	IF-BC	PERCENT CHANGE
1	0.25	0.37	0.41	0.03	8.8
2	15.20	6.13	6.34	0.20	3.3
3	23.69	20.23	18.84	-1.39	-6.9
4	161.62	9.31	7.97	-1.34	-14.4
5	95.98	5.12	5.06	-0.06	-1.1
6	18.12	2.01	3.18	1.17	58.4
7	22.22	10.23	10.88	0.65	6.4
8	27.16	3.25	3.39	0.14	4.3
9	5.17	5.41	5.26	-0.15	-2.9
10	0.14	0.13	0.13	-0.00	-2.8
TOTAL	369.75	62.20	61.45	-0.75	-1.2

THERMAL (BILLION Btu/day)

DR[a]	1972	BASE CASE	IMPORT FEE	IF-BC	PERCENT CHANGE
1	1034	1592	1062	-529	-33.3
2	1552	2176	2073	-102	-4.7
3	3999	6126	6025	-101	-1.7
4	3338	4316	4460	144	3.3
5	2000	2933	2862	-71	-2.4
6	1259	2094	2140	46	2.2
7	3671	4023	4023	0	0.0
8	984	3052	3192	140	4.6
9	1732	1181	1052	-128	-10.9
10	17	0	0	0	0.0
TOTAL	19590	27496	26893	-602	-2.2

PERCENT CHANGE IS PERCENT INCREASE OF IMPORT FEE CASE OVER BASE CASE

TABLE 5-3 (CONT.)

POLLUTION LOADINGS

PARTICULATES (tons/day)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	63.8	93.5	53.8	-39.6	-42.4
2	162.2	200.8	195.9	-4.9	-2.5
3	427.0	706.6	667.3	-39.3	-5.6
4	378.8	450.3	431.7	-18.5	-4.1
5	234.1	255.6	244.1	-10.9	-4.3
6	172.0	216.1	228.9	12.8	5.9
7	283.8	293.4	298.7	5.3	1.8
8	75.4	238.9	246.1	7.2	3.0
9	111.0	92.8	81.6	-11.2	-12.1
10	2.2	1.0	1.0	-0.0	-2.9
TOTAL	1815.4	2548.3	2449.2	-99.1	-3.9

NO(X) (tons/day)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	947	1298	922	-375	-28.9
2	1837	3031	3218	187	6.2
3	6313	8535	8412	-123	-1.4
4	5180	6503	6946	443	6.8
5	3516	4104	3996	-107	-2.6
6	1627	3487	3687	200	5.8
7	2591	4782	4821	39	0.8
8	1379	6038	6382	343	5.7
9	1122	1189	1076	-113	-9.5
10	10	7	7	0	-2.7
TOTAL	24525	38577	39471	894	1.3

SO(X) (tons/day)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	1784	1284	886	-397	-30.9
2	5155	3804	3952	148	3.9
3	15657	14035	13658	-377	-2.7
4	14307	12170	12727	556	4.6
5	5015	7521	7252	-268	-3.6
6	3909	6781	7043	262	3.9
7	5144	5182	5204	21	0.4
8	1346	2408	2540	132	5.5
9	2571	931	801	-129	-14.0
10	54	8	7	0	-4.3
TOTAL	58945	54128	54075	-52	-0.1

HYDROCARBONS (tons/day)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	16	84	76	-7	-9.2
2	1104	337	340	3	1.0
3	559	1707	1610	-97	-5.7
4	1675	867	697	-170	-19.6
5	491	194	180	-14	-7.4
6	1428	902	968	66	7.3
7	22716	13212	13374	162	1.2
8	2809	1250	1435	185	14.8
9	2179	613	600	-12	-2.1
10	171	8	8	0	-2.9
TOTAL	35153	19178	19293	114	0.6

CARBON MONOXIDE (tons/day)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	26.1	49.0	42.8	-6.3	-12.8
2	797.3	109.5	128.8	19.2	17.6
3	444.8	278.0	277.5	-0.6	-0.2
4	1251.8	212.2	239.3	27.0	12.7
5	356.0	128.2	128.4	0.2	0.2
6	469.0	98.1	106.8	8.7	8.8
7	2099.3	123.3	123.6	0.3	0.3
8	352.4	219.9	235.2	15.3	7.0
9	1272.5	34.2	31.2	-3.0	-8.8
10	31.1	0.1	0.1	-0.0	-1.5
TOTAL	7900.4	1252.7	1313.7	61.0	4.9

ALDEHYDES (tons/day)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	7.67	10.29	5.00	-5.29	-51.4
2	34.63	46.36	44.76	-1.60	-3.5
3	16.85	183.90	165.81	-18.09	-9.8
4	45.94	50.56	20.85	-29.72	-58.8
5	9.77	12.01	9.81	-2.19	-18.3
6	18.05	7.95	17.97	10.02	126.1
7	125.69	113.11	120.17	7.06	6.2
8	14.29	15.80	15.75	-0.05	-0.3
9	53.04	60.69	57.75	-2.94	-4.9
10	1.33	1.39	1.35	-0.04	-2.9
TOTAL	329.24	532.06	459.20	-42.86	-8.5

SOLIDS (1000 tons/day)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	0.5	12.7	19.7	7.0	55.5
2	160.7	67.7	85.1	17.4	25.8
3	236.7	137.3	141.8	4.5	3.3
4	224.0	118.8	146.6	27.9	23.5
5	287.2	85.0	88.5	3.5	4.1
6	9.5	33.2	38.7	5.4	16.3
7	2.1	17.0	17.3	0.3	1.7
8	6.7	462.1	465.4	3.3	0.7
9	1.0	3.8	4.0	0.2	4.9
10	0.2	0.1	0.1	-0.0	-0.3
TOTAL	928.5	937.7	1007.2	69.5	7.4

FIXED LAND (100 acres)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	2357	17103	17059	-44	-0.3
2	11115	31306	31370	63	0.2
3	5187	27416	27250	-166	-0.6
4	2428	14154	13983	-171	-1.2
5	10200	35422	35408	-13	-0.0
6	15921	24681	24814	132	0.5
7	15474	8858	8933	75	0.8
8	30503	52924	52980	56	0.1
9	64482	144018	143985	-33	-0.0
10	340	1135	1152	17	1.5
TOTAL	158012	357020	356937	-83	-0.0

MAXIMUM INCREMENTAL LAND (100 acres)

DR^a	1972	BASE CASE	IMPORT FEE	IP-BC	PERCENT CHANGE
1	0	0	0	0	0.0
2	3082	1664	1667	2	0.2
3	7750	5796	5322	-473	-8.2
4	3216	6046	8378	2332	38.6
5	4993	4154	4490	336	8.1
6	61	1100	1667	586	53.3
7	123	271	312	40	14.7
8	412	437	438	0	0.2
9	28	11	11	0	0.0
10	6	3	3	0	0.0
TOTAL	19774	19486	22311	2825	14.5

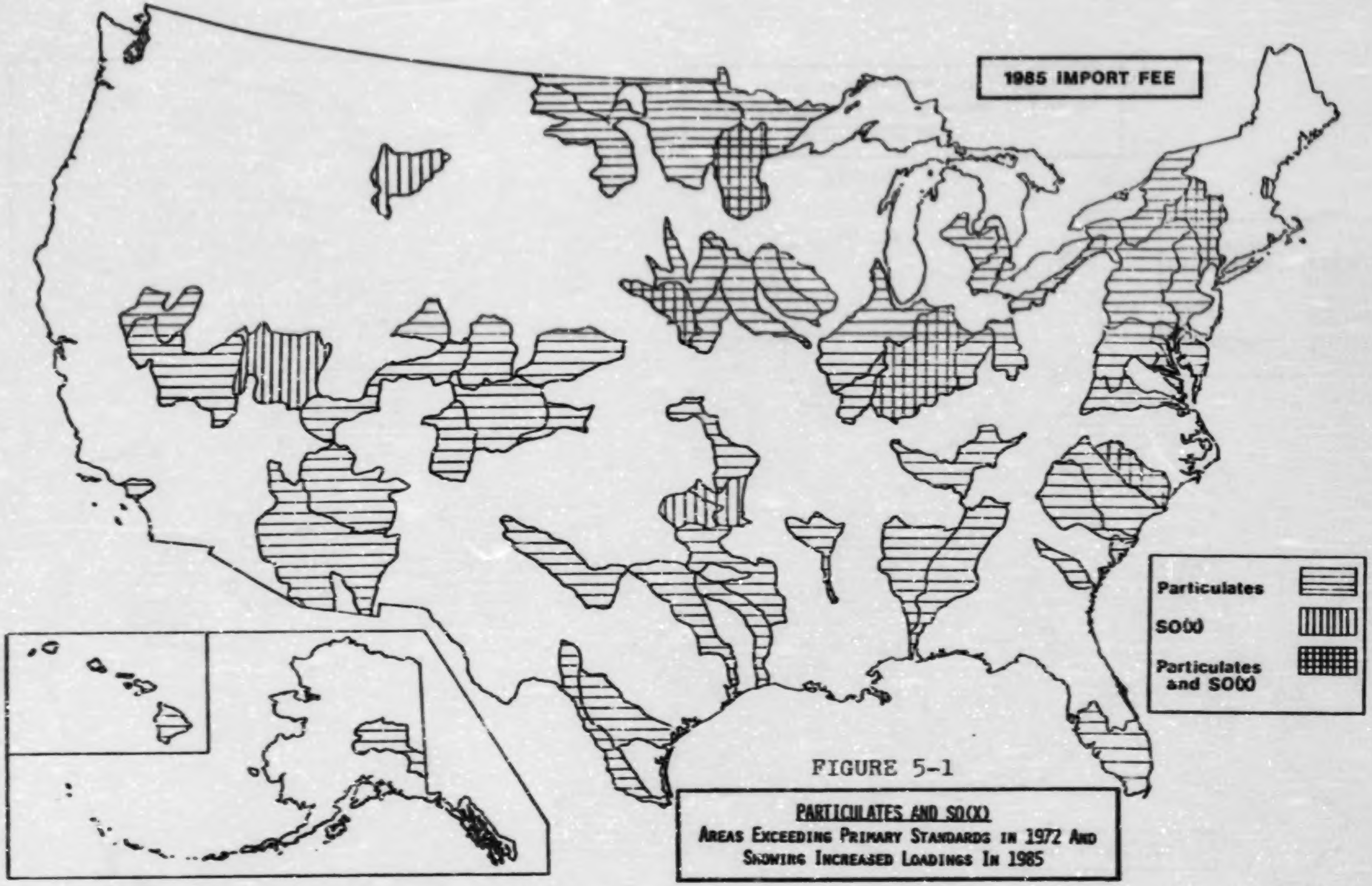

1985 IMPORT FEE
Particulates ▤
SO(X) ▥
Particulates and SO(X) ▦

FIGURE 5-1

PARTICULATES AND SO(X)

Areas Exceeding Primary Standards in 1972 And Showing Increased Loadings In 1985

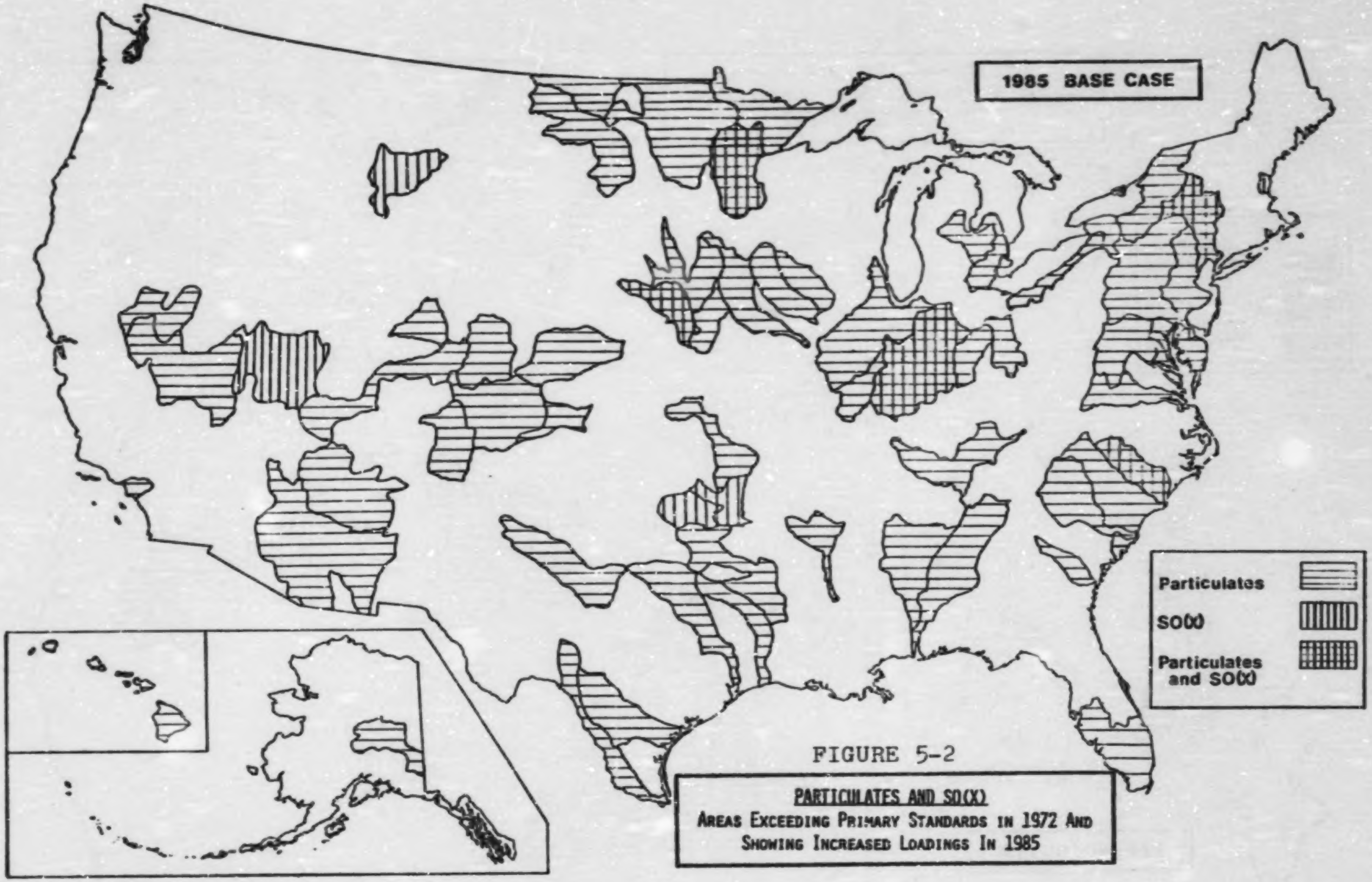

1985 BASE CASE
Particulates ▤
SO(X) ▥
Particulates and SO(X) ▦

FIGURE 5-2

PARTICULATES AND SO(X)

Areas Exceeding Primary Standards in 1972 And Showing Increased Loadings In 1985

- Demand Regions 1 and 9 which have a high proportion of oil-fired compared to coal-fired electricity generation show higher loadings of thermal, particulates, SO(x), NO(x) and carbon monoxide under the Base Case than under Import Fee. Conversely, Demand Regions 4, 6 and 8 which have a high proportion of coal-fired electricity generation show higher loadings of the same pollutants under the Import Fee Scenario.

- Demand Regions 6 and 7 show much greater refining under the Import Fee scenario than under the Base Case. This is because domestic oil production increases and inland refineries are relatively insensitive to import variations. Conversely, coastal regions (Demand Regions 3, 4, 5 and 9) show greater refining under the Base Case than the Import Fee scenario. Higher refinery levels result in higher loadings of total dissolved solids, particulates, hydrocarbons and aldehydes.

- Higher levels of underground coal mining in the Base Case in Demand Region 3 cause greater maximum incremental land use than in the Import Fee scenario. The reverse is true in Demand Regions 4, 5 and 6 where higher levels of underground coal mining are indicated by the Import Fee scenario than the Base Case.

- Because there is substantially larger oil production in Alaska (excluding the North Slope) under the Import Fee scenario than in the Base Case, organics loadings are 56 percent higher in Demand Region 10.

Predicted radiation loadings for each 1985 scenario are shown in Table 5-4. These loadings are based on the assumption of "normal" operation (i.e., no nuclear accidents) and compliance with all radiation standards.[1,2] Table 5-5

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[1] U.S. Atomic Energy Commission, Survey of Uranium Fuel Cycle, April 1974.

[2] U.S. Environmental Protection Agency, Environmental Analysis of Uranium Fuel Cycle, October 1973.

TABLE 5-4

PREDICTED RADIATION LOADINGS[a]

NUCLEAR POWER PLANTS Electric Utility Region	U-235 (tons/day)	MEDIUM		
		Air (curies/day)	Water (curies/day)	Solids (curies/day)
1	.066	79.988	19.079	0
2	.024	29.086	6.938	0
3	.077	94.531	22.548	0
4	.066	79.988	19.079	0
5	.012	14.543	3.468	0
6	.072	87.259	20.814	0
7	.185	225.42	53.768	0
8	.030	36.358	8.672	0
9	.066	79.988	19.079	0
Total From Power Plants	Used .598	727.162	173.446	0
Uranium Fuel Cycle Except Power Plants	Produced .598	177022.171	1203.989	290.269
National Total	-	177749.333	1377.435	290.269

[a] Radioactivity from the wastes of nuclear power plants stored in nuclear waste disposal facilities is not included.

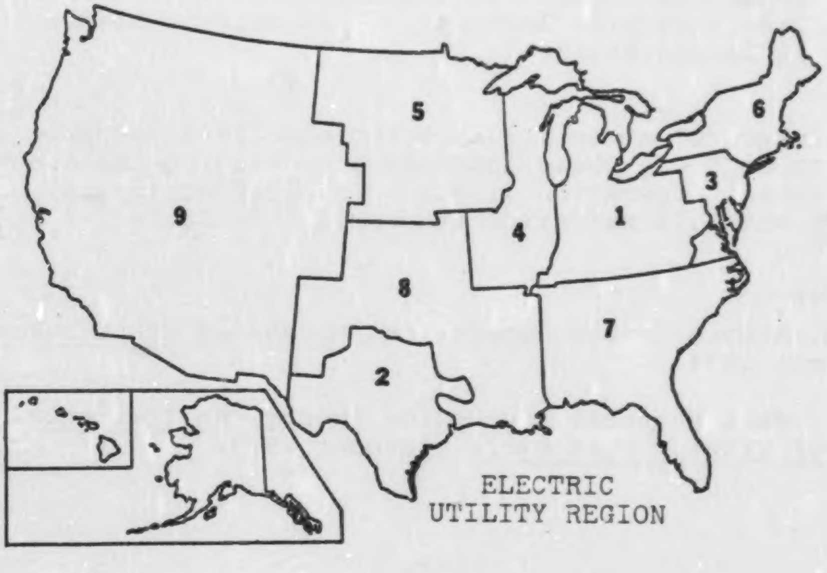

TABLE 5-5

POLLUTION LOADINGS FROM URANIUM FUEL CYCLE

(Except Nuclear Power Plants)

POLLUTANTS	BASE CASE	IMPORT FEE CASE
Acids (tons/day)	0.000	0.000
Bases (tons/day)	0.000	0.000
TDS (100 tons/day)	0.494	0.494
SS (tons/day)	0.000	0.000
Organics (100 tons/day)	0.000	0.000
Thermal (E9 Btu/day)	0.000	0.000
Particulates (tons/day)	3.195	3.195
NO(x) (tons/day)	14.364	14.364
SO(x) (tons/day)	15.974	15.974
HC (tons/day)	1.222	1.222
CO (tons/day)	0.107	0.107
Aldehydes (tons/day)	0.383	0.383
Solids (1,000 tons/day)	48.398	48.398
Fixed Land (100 acres)	1,015.970	1,015.970
Max. In. Land (100 acres)	0.000	0.000

presents loadings of non-radioactive pollutants from the entire uranium fuel cycle except nuclear power plants. These loadings are those predicted for mining, milling, uranium hexaflouride production, fabrication, reprocessing and waste disposal. There are no differences between the scenarios because nuclear development is predicted to be the same for both.

CHAPTER SIX

ENERGY INDEPENDENCE ACT

6.1 Description of Scenarios

FEA provided Environment Reports and PIES Model Reports of the following scenarios for analysis. The results were included in the Draft Environmental Impact Statement: Energy Independence Act of 1975 and Related Tax Proposals[1] of March 1975:

- EIA -- Energy Independence Act -- $7 for imported oil (FEA #85ACC4A, DO7TO2A, I07MOD8)
- BAU -- Business-as-Usual -- $7 for imported oil (FEA #85BAU2B, DO7RM, E70RM, I7MOD5)
- AS -- Accelerated Supply -- $7 for imported oil (FEA #85ACC4A, D11TO2A, E11TO2A, I11MOD8)
- AC -- Accelerated Conservation -- $7 for imported oil (FEA #85ACC4A, DO7TO2C, EO7TO2C, I07MOD8)
- RS -- Reduced Supply -- $7 for imported oil (FEA #85BAU4A, DO7TO2A, E07TO2A, I07MOD9)
- RC -- Reduced Conservation -- $7 for imported oil (FEA #85ACC4A, DO7RM, E70RM, I07MODA)

A more detailed description of the scenarios is:[2]

1. Energy Independence Act (EIA) or President's Program
    - crude oil and natural gas deregulation
    - import fees ($2/barrel)

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[1] Federal Energy Administration, Draft Environmental Impact Statement: Energy Independence Act of 1975 and Related Tax Proposals, March 1975.

[2] FEA, Draft Environmental Impact Statement, March 1975.

- excise taxes on petroleum ($2/barrel) and natural gas (36 cents/1,000 cubic feet)
- windfall profits tax
- coal conversions (400 million barrels/day)
- accelerated oil and gas production
  - Elk Hills
  - NPR 4
  - Outer Continental Shelf
- energy conservation measures
  - public education
  - auto fuel economy
  - thermal standards for buildings
  - residential conservation programs
  - appliance efficiency standards labeling
- strategic petroleum storage
- backup oil import program and standby authorities
- energy price uncertainty reduction authority
- coal leasing and surface mining initiatives
- Clean Air Act amendments
- nuclear power, electric utility, and energy facility siting initiatives
- long-term research and development programs
- synthetic fuels commercialization

2. Business-as-Usual, No Initiative Case

   The Business-as-Usual scenario is defined as a scenario in which no new actions are taken.

3. Accelerated Supply Scenario (AS)

   The increased domestic energy supply case is defined to include all the initiatives of the President's program except that the import fees are increased from $2 per barrel to $6 per barrel. This has the effect of stimulating domestic oil and gas production and increasing the consumption of coal as utilities take steps to avoid burning more expensive imported oil. It also has the effect of reducing energy consumption as higher prices stimulate increased energy conservation. Hence, this case is actually an increased supply and conservation case since the policies that would stimulate supply also result in reduced demand.

4. Accelerated Conservation Scenario (AC)

The increased energy conservation case is defined to include all initiatives of the President's program plus additional measures to stimulate increased energy conservation. Such measures might include automobile fuel economy regulations greater than the current agreement to attain 19.6 mpg, a gasoline tax in addition to the import fees and crude oil deregulation and mandatory lighting standards for commercial buildings. Estimates of the incremental effects of these measures are necessarily imprecise, since much of this conservation will result from the higher energy prices associated with deregulation, oil import fees, and excise taxes.

5. Reduced Supply Scenario (RS)

The reduced domestic energy supply case is defined to include all the initiatives of the President's program except:

- oil-to-coal power plant conversions
- accelerated oil and gas production

Deleting the coal conversion program means that less coal and more oil would be burned in the utility sector. Deleting the accelerated production initiative means less domestic oil and gas would be produced. Each deletion means more oil imports. To be consistent with the concept of reduced supply, the crude oil and natural gas deregulation items should have been deleted from the President's program as well. However, the Project Independence energy model is built on the assumption of free energy markets and cannot simulate the effects of regulated prices. Hence, the effect of regulation/deregulation is not included in the model projections.

6. Reduced Conservation Scenario (RC)

The reduced energy conservation case is defined to include the same initiatives as the President's program except deletion of:

- import fees and excise tax
- energy conservation measures

The energy conservation measures reduce energy consumption directly. The import fees and excise taxes increase oil and gas prices in order to reduce energy consumption and accelerated substitution of coal for oil and gas in certain sectors. Deleting both measures means more energy consumption and oil imports.

The 1972 scenario reflecting 1972 levels of activity was also included for comparison.

6.2 Major Energy Features

Comparison of the national energy production activities for each scenario to EIA shows:

- Underground coal production is 20 percent greater under AS and 30 percent less under BAU and RC than under EIA;
- Surface coal production is 6 percent less under BAU and RC than EIA;
- Natural gas production is 20 percent greater under RC than EIA;
- Oil production is 32 percent less under BAU and RS and 10 percent greater under AS than EIA;
- Refining activity is 18 percent greater under BAU and RC and 12 percent less under AS than EIA;
- Coal-fired electricity generation is 19 percent less under BAU and RC and 9 percent greater under AS than EIA;

- Oil-fired electricity generation is 29 percent less under BAU and RC and 56 percent less under AS than under EIA.

Comparison of EIA to 1972 shows:

- A large increase in domestic production of fuels including 87 percent more coal and 42 percent more oil plus production of oil from shale. There is a 16 percent decrease in natural gas production;

- Refining activity increases by almost 25 percent;

- There is more than a doubling of all forms of power generation except gas-fired which decreases by 27 percent.

Production levels for all activities are shown in Table 6-1. A more detailed analysis is in Table 6-2, with Figure 6-1 showing regional definitions.

6.3 Analysis

The 1985 pollution loadings are based on the assumption that existing air and water quality laws are fully implemented and that surface mine reclamation regulations are implemented. Under these assumptions, while energy production increases by over 50 percent, most pollution loadings either increase much less than energy production or actually decline. Application of advanced abatement technology not only implies no relaxation of existing air and water quality laws, but also an active and effective monitoring and enforcement effort at both the national and state levels. Since the proposal for delay in compliance with the Clean Air Act contemplates full compliance by 1985, the technology assumptions are valid for analysis of the Energy Independence Act.

Table 6-3 shows the comparison of the Energy Independence Act with the other scenarios. For this set of scenarios pollution loadings from the end use of energy were computed at the national level only. Therefore, levels of residuals from the end use of energy are included in Table 6-3 and Figure 6-2 only. The table shows that there is very little difference in pollution loadings among the scenarios. Any method for quantitatively ranking the scenarios requires a technique for weighting the importance of different pollutants and different regions.

TABLE 6-1

NATIONAL ENERGY PRODUCTION UNDER DIFFERENT FEA SCENARIOS

	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON	UNITS[a]
Surface Coal	753.887	1788.96	1677.71	1754.16	1769.07	1798.05	1690.46	(E3 tons/day)
Underground Coal	876.791	1253.82	904.044	1502.69	1240.1	1204.13	866.327	(E3 tons/day)
Natural Gas	72208.1	60304.	64098.7	61831.6	57919.2	56440.6	72128.4	(E6 Scf/day)
Oil	9224.29	13142.	8877.12	14437.1	13142.	8877.12	12542.	(E3 bbls/day)
Hi Btu Gasification	0	0	0	0	0	0	0	(E6 Scf/day)
Coal Liquefaction	0	0	0	0	0	0	0	(E3 bbls/day)
Lo Btu Gasification	0	0	0	0	0	0	0	(E6 Scf/day)
Oil Shale	0	250	0	250	250	250	250	(E3 bbls/day)
Power Plants								
Coal-Fired	914.485	2124.72	1727.73	2319.75	2080.58	2083.16	1710.83	(E3 tons/day)
Oil-Fired	1204.07	2627.99	3395.4	1143.27	2565.84	2825.13	3379.95	(E3 bbls/day)
Gas-Fired	9354.12	6804.33	7054.75	6671.48	6804.33	6931.83	6898.51	(E6 Scf/day)
Turbines	0	0	0	0	0	0	0	(E3 bbls/day)
Nuclear	0.3433	0.598	0.598	0.598	0.598	0.598	0.598	(tons U-235/day)
Hydroelectric	77.3212	195.094	195.094	195.094	195.094	195.094	195.094	(E3 MW)
Refineries	13853.	17064.6	20008.5	16350.4	16350.4	17045.9	20071.1	(E3 bbls/day)

[a] Definitions:
E3 is 1,000
E6 is 1,000,000
bbl is a barrel or 42 gallons
MW is one million watts
Scf is a cubic foot at standard temperature and pressure

TABLE 6-2

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

RESOURCE ACTIVITY	ENERGY INDEPENDENCE ACT vs. 1972	BUSINESS AS USUAL vs. EIA	ACCELERATED SUPPLY vs. EIA	ACCELERATED CONSERVATION vs. EIA	REDUCED SUPPLY vs. EIA	REDUCED CONSUMPTION vs. EIA
ALL COAL PRODUCTION	NATIONAL: 87% INCREASE TO 3,094,260 TONS PER DAY	NATIONAL: 15% LESS AT 2,523,019 TONS PER DAY	NATIONAL: 7% GREATER AT 3,252,600 TONS PER DAY	NATIONAL: 1% LESS AT 3,010,830 TONS PER DAY	NATIONAL: 2% LESS AT 3,039,030 TONS PER DAY	NATIONAL: 20% LESS AT 2,557,480 TONS PER DAY
UNDERGROUND COAL PRODUCTION	NATIONAL: 43% INCREASE TO 1,255,299 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 3 - 439% INCREASE TO 782,205 TONS PER DAY 2) COAL SUPPLY REGION 5 - 957% INCREASE TO 8,219 TONS PER DAY 3) COAL SUPPLY REGION 1 - 45% DECREASE TO 172,494 TONS PER DAY 4) COAL SUPPLY REGION 2 - 29% DECREASE TO 278,636 TONS PER DAY 5) COAL SUPPLY REGION 6 - 44% DECREASE TO 13,690 TONS PER DAY	NATIONAL: 28% LESS AT 905,334 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 3 - 44% LESS AT 436,240 TONS PER DAY	NATIONAL: 20% GREATER AT 1,504,528 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 1 - 44% GREATER AT 248,206 TONS PER DAY 2) COAL SUPPLY REGIONS 2 AND 3 ARE SLIGHTLY GREATER	NATIONAL: 1% LESS AT 1,255,290 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 2 - 2% LESS AT 272,117 TONS PER DAY 2) COAL SUPPLY REGION 3 - 1% LESS AT 775,052 TONS PER DAY	NATIONAL: 4% LESS AT 1,205,900 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 3 - 7% LESS AT 728,703 TONS PER DAY 2) COAL SUPPLY REGION [illegible] - 1% GREATER AT 262,945 TONS PER DAY	NATIONAL: 32% LESS AT 867,841 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 3 - 40% LESS AT 469,536 TONS PER DAY 2) COAL SUPPLY REGION 2 - 2% LESS AT 272,117 TONS PER DAY
SURFACE COAL PRODUCTION	NATIONAL: 137% INCREASE TO 1,788,961 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 4 - 753% INCREASE 94,698 TONS PER DAY 2) COAL SUPPLY REGION 5 - 714% INCREASE TO 557,273 TONS PER DAY 3) COAL SUPPLY REGION 2 - 342% INCREASE TO 377,830 TONS PER DAY 4) COAL SUPPLY REGION 6 - 37% DECREASE TO 21,924 TONS PER DAY	NATIONAL: 6% LESS AT 1,677,700 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 4 - 27% LESS AT 69,128 TONS PER DAY 2) COAL SUPPLY REGION 5 - 15% LESS AT 471,524 TONS PER DAY.	NATIONAL: 2% LESS AT 1,754,152 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGIONS 4 AND 5 ARE SLIGHTLY LESS	NATIONAL: 1% LESS AT 1,760,560 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 5 - 4% LESS AT 537,300 TONS PER DAY	NATIONAL: 1% GREATER AT 1,798,063 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 4 - 30% GREATER AT 127,795 TONS PER DAY 2) COAL SUPPLY REGION 5 - 5% LESS AT 530,250 TONS PER DAY	NATIONAL: 2% LESS AT 1,090,450 TONS PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGION 5 - 20% LESS AT 490,675 TONS PER DAY 2) COAL SUPPLY REGION 4 - 2% LESS AT 93,040 TONS PER DAY
OIL PRODUCTION	NATIONAL: 42% INCREASE TO 13,145,900 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) THERE ARE SUBSTANTIAL DECREASES TO ALL PETROLEUM SUPPLY REGIONS EXCEPT THE NORTH SLOPE, 1, 2A, 4, 6A, AND 11A. 2) NORTH SLOPE OF ALASKA - DEVELOPED FROM A VIRGIN AREA TO 4,500,000 BARRELS PER DAY 3) PETROLEUM SUPPLY REGION 1 - 230% INCREASE TO 658,630 BARRELS PER DAY 4) PETROLEUM SUPPLY REGION 2A - 1009% INCREASE TO 1,121,600 BARRELS PER DAY 5) PETROLEUM SUPPLY REGION 4 - 51% INCREASE TO 258,100 BARRELS PER DAY 6) PETROLEUM SUPPLY REGION 6A - 70% INCREASE TO 1,185,400 BARRELS PER DAY 7) PETROLEUM SUPPLY REGION 11A - DEVELOPED FROM A VIRGIN AREA TO 430,520 BARRELS PER DAY	NATIONAL: 32% LESS AT 8,878,600 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 11A - 92% LESS AT 37,700 BARRELS PER DAY 2) PETROLEUM SUPPLY REGION 1 - 91% LESS AT 52,560 BARRELS PER DAY 3) PETROLEUM SUPPLY REGION 2A - 58% LESS AT 515,800 BARRELS PER DAY 4) PETROLEUM SUPPLY REGION 2 - 26% LESS AT 495,500 BARRELS PER DAY 5) NORTH SLOPE OF ALASKA - 44% LESS AT 2,500,050 BARRELS PER DAY 6) PETROLEUM SUPPLY REGION 6A - 18% LESS AT 1,548,400 BARRELS PER DAY	NATIONAL: 10% GREATER AT 14,440,000 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 3 - 200% GREATER AT 296,300 BARRELS PER DAY 2) PETROLEUM SUPPLY REGION 6 - 61% GREATER AT 2,439,100 BARRELS PER DAY 3) PETROLEUM SUPPLY REGION 1 - 17% GREATER AT 741,900 BARRELS PER DAY	IDENTICAL TO EIA	NATIONAL: 35% LESS AT [illegible] BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 11A - 92% LESS AT 37,700 BARRELS PER DAY 2) PETROLEUM SUPPLY REGION 1 - 91% LESS AT 58,900 BARRELS PER DAY 3) PETROLEUM SUPPLY REGION 2A - 58% LESS AT 515,890 BARRELS PER DAY 4) PETROLEUM SUPPLY REGION 2 - 26% LESS AT 495,530 BARRELS PER DAY 5) NORTH SLOPE OF ALASKA - 44% LESS AT 2,500,000 BARRELS PER DAY 6) PETROLEUM SUPPLY REGION 6A - 18% LESS AT 1,548,400 BARRELS PER DAY IDENTICAL TO BAU	NATIONAL: 1% LESS AT 12,945,950 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 1 - 92% LESS AT 53,900 BARRELS PER DAY
OIL IMPORTS	IMPORT TOTAL - LESS THAN 1% DECREASE TO 4,725,900 BARRELS PER DAY IMPORTED CRUDE - 53% INCREASE TO 3,393,006 BARRELS PER DAY IMPORTED REFINED - 43% DECREASE TO 1,333,400 BARRELS PER DAY	IMPORT TOTAL - 171% GREATER AT 12,787,600 BARRELS PER DAY IMPORTED CRUDE - 214% GREATER AT 10,669,000 BARRELS PER DAY IMPORTED REFINED - 60% GREATER AT 2,118,600 BARRELS PER DAY	THERE ARE NO OIL IMPORTS	IMPORT TOTAL - 10% LESS AT 4,244,100 BARRELS PER DAY IMPORTED CRUDE - 21% LESS AT 2,693,900 BARRELS PER DAY IMPORTED REFINED - 17% GREATER AT 1,550,100 BARRELS PER DAY	IMPORT TOTAL - 94% GREATER AT 9,169,600 BARRELS PER DAY IMPORTED CRUDE - 124% GREATER AT 7,611,620 BARRELS PER DAY IMPORTED REFINED - 18% GREATER AT 1,558,000 BARRELS PER DAY	IMPORT TOTAL - 81% GREATER AT 8,557,400 BARRELS PER DAY IMPORTED CRUDE - 104% GREATER AT 6,928,100 BARRELS PER DAY IMPORTED REFINED - 29% GREATER AT 1,629,300 BARRELS PER DAY

TABLE 6-2 (CONT.)

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

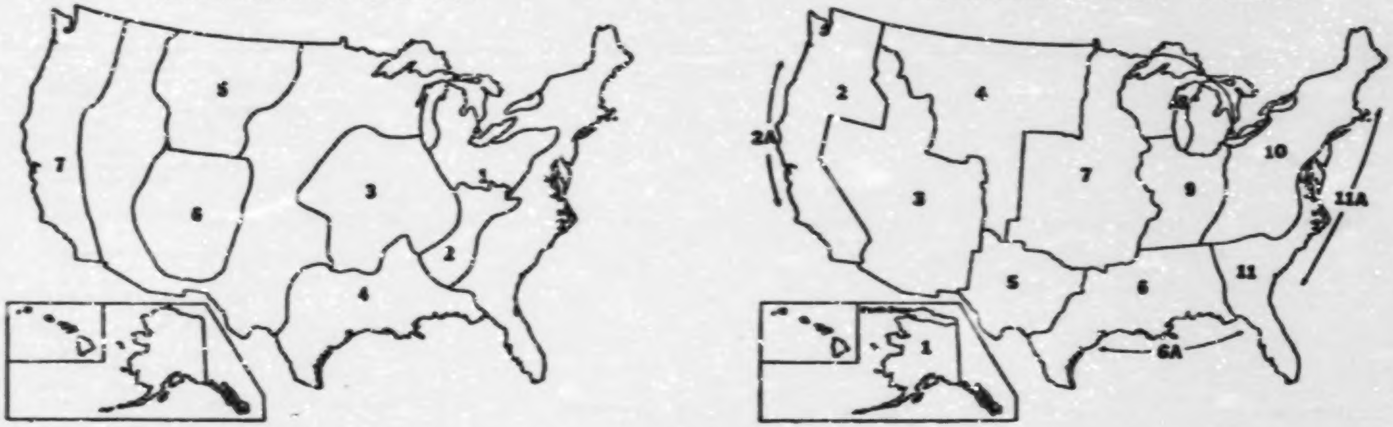
RESOURCE ACTIVITY	ENERGY INDEPENDENCE ACT vs. 1972	BUSINESS AS USUAL vs. EIA	ACCELERATED SUPPLY vs. EIA	ACCELERATED CONSERVATION vs. EIA	REDUCED SUPPLY vs. EIA	REDUCED CONSERVATION vs. EIA
NATURAL GAS PRODUCTION	NATIONAL: 16% DECREASE TO 60,204.3 MILLION STANDARD CUBIC FEET (SCF) PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGIONS 2, 5, 6, AND 11 DECREASE BY MORE THAN 50% 2) PETROLEUM SUPPLY REGION 2A - 1752% INCREASE TO 3334.8 MILLION SCF PER DAY 3) THERE ARE ALSO INCREASES IN PETROLEUM SUPPLY REGIONS 3, 4, 6A, AND 8-9-10 4) NORTH SLOPE OF ALASKA - DEVELOPED FROM A VIRGIN AREA TO 6765.5 MILLION SCF PER DAY 5) PETROLEUM SUPPLY REGION 11A - DEVELOPED FROM A VIRGIN AREA TO 392 MILLION SCF PER DAY	NATIONAL: 6% GREATER AT 64,098.5 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 5 - 102% GREATER AT 7,[illegible]6.8 MILLION SCF PER DAY 2) PETROLEUM SUPPLY REGION 2 - 89% GREATER AT [illegible]7.8 MILLION SCF PER DAY 3) PETROLEUM SUPPLY REGION 6 - 23% GREATER AT 17,[illegible] MILLION SCF PER DAY 4) PETROLEUM SUPPLY REGION 6A - 20% GREATER AT 18,976.3 MILLION SCF PER DAY 5) PETROLEUM SUPPLY REGION 3 - 54% LESS AT 2,250.6 MILLION SCF PER DAY 6) PETROLEUM SUPPLY REGIONS 1, 2A, 4, 11A, AND THE NORTH SLOPE ARE ALL SIGNIFICANTLY LESS	NATIONAL: 3% LESS AT 61,813.9 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 3 - 25% LESS AT 3768.15 MILLION SCF PER DAY 2) PETROLEUM SUPPLY REGIONS 6 AND 6 A ARE SLIGHTLY GREATER	NATIONAL: 4% LESS AT 57,900.1 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 1 - 93% LESS AT 20,329 BARRELS PER DAY 2) PETROLEUM SUPPLY REGION 6A - 24% LESS AT 13,646,600 BARRELS PER DAY	NATIONAL: 6% LESS AT 56,392.4 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) NORTH SLOPE OF ALASKA - 44% LESS AT 3,758.6 MILLION SCF PER DAY 2) PETROLEUM SUPPLY REGION 1 - 92% LESS AT 20.1 MILLION SCF PER DAY 3) PETROLEUM SUPPLY REGION 2A - 53% LESS AT 473.38 MILLION SCF PER DAY 4) PETROLEUM SUPPLY REGION 3 - 77% LESS AT 1042.95 MILLION SCF PER DAY 5) PETROLEUM SUPPLY REGION 7 - 5% LESS AT 7686.1 MILLION SCF PER DAY 6) PETROLEUM SUPPLY REGION 11A - 78% LESS AT 87.28 MILLION SCF PER DAY 7) PETROLEUM SUPPLY REGIONS 2, 5, AND 6A ARE SUBSTANTIALLY GREATER	NATIONAL: 20% GREATER AT 72,051.3 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 2- 91% GREATER AT 963.11 MILLION SCF PER DAY 2) PETROLEUM SUPPLY REGION 4- 40% GREATER AT 3,187.07 MILLION SCF PER DAY 3) PETROLEUM SUPPLY REGION 5- 113% GREATER AT 8,167.4 MILLION SCF PER DAY 4) PETROLEUM SUPPLY REGION 6A - 29% GREATER AT 20,446.8 MILLION SCF PER DAY 5) PETROLEUM SUPPLY REGION 11A - 125% GREATER AT 883.58 MILLION SCF PER DAY 6) PETROLEUM SUPPLY REGION 1 - 94% LESS AT 19.8 MILLION SCF PER DAY
OIL SHALE PRODUCTION	NATIONAL: DEVELOPED TO 250,000 BARRELS PER DAY - ALL PRODUCTION IS SURFACE AND IS LOCATED IN THE ROCKY MOUNTAIN REGION.	THERE IS NO OIL SHALE DEVELOPMENT	IDENTICAL TO EIA	IDENTICAL TO EIA	IDENTICAL TO EIA	IDENTICAL TO EIA
REFINERIES	NATIONAL: 23% INCREASE TO 17,084,634 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PAD 1A - 5693% INCREASE TO 5,585,653 BARRELS PER DAY 2) THERE ARE SLIGHT INCREASES IN PAD'S 1B AND 4 3) PAD 2A - 55% DECREASE TO 744,962 BARRELS PER DAY 4) PAD 2B - 23% DECREASE TO 1,184,157 BARRELS PER DAY 5) THERE ARE SLIGHT DECREASES IN PAD'S 3 AND 5.	NATIONAL: 17% GREATER AT 20,026,700 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PAD 2A - 213% GREATER AT 2,329,000 BARRELS PER DAY 2) PAD 5 - 30% GREATER AT 2,752,300 BARRELS PER DAY 3) PAD 1A - 27% GREATER AT 7,096,500 BARRELS PER DAY 4) PAD 2B - 62% LESS AT 448,800 BARRELS PER DAY 5) PAD 4 - 45% LESS AT 258,300 BARRELS PER DAY	NATIONAL: 12% LESS AT 14,577,786 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PAD 1A - 43% LESS AT 3,171,042 BARRELS PER DAY 2) PAD 4 - 93% LESS AT 33,766 BARRELS PER DAY 3) PAD 2B - 60% GREATER AT 1,189,917 BARRELS PER DAY 4) PAD 5 - 25% GREATER AT 2,638,523 BARRELS PER DAY	NATIONAL: 4% LESS AT 16,358,433 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PAD 1A - 6% LESS AT 5,252,350 BARRELS PER DAY 2) PAD 3 - 6% LESS AT 4,756,080 BARRELS PER DAY 3) PAD 5 - 4% LESS AT 2,041,230 BARRELS PER DAY	NATIONAL: .1% LESS AT 17,065,894 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PAD 2B - 4% LESS AT 1,132,463 BARRELS PER DAY 2) PAD'S 2A AND 5 ARE SLIGHTLY GREATER	NATIONAL: 18% GREATER AT 20,071,111 BARRELS PER DAY MAJOR REGIONAL ASPECTS 1) PAD 2A - 213% GREATER AT 2,329,000 BARRELS PER DAY 2) PAD 5 - 30% GREATER AT 2,752,373 BARRELS PER DAY 3) PAD 1A - 24% GREATER AT 6,949,620 BARRELS PER DAY 4) PAD 2B - 66% LESS AT 400,041 BARRELS PER DAY
COAL-FIRED POWER PLANTS	NATIONAL: 345% INCREASE TO 2,124,659 TONS PER DAY MAJOR REGIONAL ASPECTS 1) THERE ARE SUBSTANTIAL INCREASES IN ALL ELECTRIC UTILITY REGIONS 2) ELECTRIC UTILITY REGION 2 - 3026% INCREASE TO 87,344 TONS PER DAY 3) ELECTRIC UTILITY REGION 6 - 1562% INCREASE TO 254,883 TONS PER DAY 4) ELECTRIC UTILITY REGION 9 - 984% INCREASE TO 478,511 TONS PER DAY 5) ELECTRIC UTILITY REGION 8 - 393% INCREASE TO 45,930 TONS PER DAY 6) ELECTRIC UTILITY REGIONS 1, 4, AND 5 INCREASE BY MORE THAN 300%	NATIONAL: 19% LESS AT 1,727,000 TONS PER DAY MAJOR REGIONAL ASPECTS 1) ALL ELECTRIC UTILITY REGIONS ARE BETWEEN 10% AND 37% LESS EXCEPT ELECTRIC UTILITY REGION 7 2) ELECTRIC UTILITY REGION 7 - 4% GREATER AT 298,400 TONS PER DAY	NATIONAL: 9% GREATER AT 2,319,866 TONS PER DAY MAJOR REGIONAL ASPECTS 1) ELECTRIC UTILITY REGION 3 - 143% GREATER AT 255,159 TONS PER DAY 2) ELECTRIC UTILITY REGIONS 1, 5, AND 7 ARE SLIGHTLY GREATER 3) ELECTRIC UTILITY REGION 6 - 28% LESS AT 181,846 TONS PER DAY 4) ELECTRIC UTILITY REGIONS 4, 8, AND 9 ARE SLIGHTLY LESS	NATIONAL: 2% LESS AT 2,080,500 TONS PER DAY MAJOR REGIONAL ASPECTS 1) ELECTRIC UTILITY REGION 3 - 8% LESS AT 97,270 TONS PER DAY 2) ELECTRIC UTILITY REGION 5 - 8% LESS AT [illegible],874 TONS PER DAY 3) ELECTRIC UTILITY REGIONS 4, 6, 7, AND 9 ARE SLIGHTLY LESS	NATIONAL: 2% LESS AT 2,085,162 TONS PER DAY MAJOR REGIONAL ASPECTS 1) ELECTRIC UTILITY REGION [illegible] - 34% LESS AT 27,518 TONS PER DAY 2) ELECTRIC UTILITY REGION 8 - 21% LESS AT 36,445 TONS PER DAY 3) ELECTRIC UTILITY REGIONS 1, 5, AND 9 ARE SLIGHTLY LESS 4) ELECTRIC UTILITY REGION 2 - 32% INCREASE TO 115,391 TONS PER DAY	NATIONAL: 19% LESS AT 1,730,830 TONS PER DAY MAJOR REGIONAL ASPECTS 1) ELECTRIC UTILITY REGION 1 - 29% LESS AT 457,967 TONS PER DAY 2) ELECTRIC UTILITY REGION 4 - 30% LESS AT 360,027 TONS PER DAY 3) ELECTRIC UTILITY REGION 6 - 38% LESS AT 86,114 TONS PER DAY 4) ELECTRIC UTILITY REGION 8 - 21% LESS AT 36,445 TONS PER DAY 5) ELECTRIC UTILITY REGION 9 - 20% LESS AT 361,757 TONS PER DAY 6) ELECTRIC UTILITY REGIONS 3 AND 7 ARE SLIGHTLY GREATER

TABLE 6-2 (CONT.)

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

RESOURCE ACTIVITY	ENERGY INDEPENDENCE ACT vs. 1972	BUSINESS AS USUAL vs. EIA	ACCELERATED SUPPLY vs. EIA	ACCELERATED CONSERVATION vs. EIA	REDUCED SUPPLY vs. EIA	REDUCED CONSERVATION vs. EIA
OIL-FIRED POWER PLANTS	NATIONAL: [illegible] increase to [illegible] barrels per day Major Regional Aspects 1) There are substantial increases in all Electric Utility Regions except 6. 2) Electric Utility Region 6 - [illegible] decrease to [illegible] barrels per day 3) Electric Utility Region 2 - from zero production in 1972 to [illegible] barrels per day 4) Electric Utility Region 8 - [illegible] increase to [illegible] barrels per day 5) Electric Utility Region 1 - [illegible] increase to [illegible] barrels per day 6) Electric Utility Region 4 - [illegible] increase to [illegible] barrels per day 7) Electric Utility Region 5 - [illegible] increase to [illegible] barrels per day 8) Electric Utility Region 7 - [illegible] increase to [illegible] barrels per day 9) Electric Utility Region 9 - [illegible] increase to [illegible] barrels per day	NATIONAL: [illegible] greater at [illegible] barrels per day Major Regional Aspects 1) Electric Utility Region 2 - [illegible] greater at [illegible] barrels per day 2) Electric Utility Region 4 - [illegible] greater at [illegible] barrels per day 3) Electric Utility Region 5 - [illegible] greater at [illegible] barrels per day 4) Electric Utility Region 6 - [illegible] greater at [illegible] barrels per day 5) Electric Utility Region 9 - [illegible] greater at [illegible] barrels per day 6) Electric Utility Region 8 - [illegible] greater at [illegible] barrels per day 7) Electric Utility Region 7 - [illegible] greater at [illegible] barrels per day 8) Electric Utility Region 3 - [illegible] less at [illegible] barrels per day	NATIONAL: [illegible] less at [illegible] barrels per day Major Regional Aspects 1) All Electric Utility Regions are less except 5. 2) Electric Utility Region 1 - [illegible] less at [illegible] barrels per day 3) Electric Utility Region 3 - [illegible] less at [illegible] barrels per day 4) Electric Utility Region 6 - [illegible] less at [illegible] barrels per day 5) Electric Utility Region 7 - [illegible] less at [illegible] barrels per day 6) Electric Utility Region 8 - [illegible] less at [illegible] barrels per day	NATIONAL: [illegible] less at [illegible] barrels per day Major Regional Aspects 1) Electric Utility Region 7 - [illegible] less at [illegible] barrels per day 2) Electric Utility Region 5 - [illegible] less at [illegible] barrels per day 3) Electric Utility Regions 3, 4, 6, and 9 are slightly less.	NATIONAL: [illegible] greater at [illegible] barrels per day Major Regional Aspects 1) Electric Utility Region 2 - [illegible] greater at [illegible] barrels per day 2) Electric Utility Region 4 - [illegible] greater at [illegible] barrels per day 3) Electric Utility Region 5 - [illegible] greater at [illegible] barrels per day 4) Electric Utility Region 8 - [illegible] greater at [illegible] barrels per day	NATIONAL: [illegible] greater at [illegible] barrels per day Major Regional Aspects 1) Electric Utility Region [illegible] - [illegible] greater at [illegible] barrels per day 2) Electric Utility Region 6 - [illegible] greater at [illegible] barrels per day 3) Electric Utility Region 9 - [illegible] greater at [illegible] barrels per day 4) Electric Utility Regions 7 and 8 are slightly greater 5) Electric Utility Regions 1, 3, and 5 are slightly less
NATURAL GAS-FIRED POWER PLANTS	NATIONAL: [illegible] increase to [illegible] million standard cubic feet (SCF) per day Major Regional Aspects 1) Electric Utility Regions 4, 5, 6, 7, and 9 decrease by more than [illegible] 2) Electric Utility Region 2 - [illegible] increase to [illegible] million SCF per day 3) Electric Utility Region 3 - from zero production in 1972 to [illegible] million SCF per day	NATIONAL: [illegible] greater at [illegible] million SCF per day Major Regional Aspects 1) Electric Utility Region 2 - [illegible] greater at [illegible] million SCF per day 2) Electric Utility Region 8 - [illegible] greater at [illegible] million SCF per day	NATIONAL: [illegible] less at [illegible] million SCF per day Major Regional Aspects 1) Electric Utility Region [illegible] - [illegible] less at [illegible] million SCF per day 2) Electric Utility Regions 2 and 8 are slightly less	Identical to EIA	NATIONAL: [illegible] greater at [illegible] million SCF per day Major Regional Aspects 1) Electric Utility Region 8 - [illegible] greater at [illegible] million SCF per day 2) Electric Utility Region 2 - [illegible] greater at [illegible] million SCF per day	NATIONAL: [illegible] greater at [illegible] million SCF per day Major Regional Aspects 1) Electric Utility Region [illegible] - [illegible] greater at [illegible] million SCF per day
HYDRO-ELECTRIC POWER PLANTS	NATIONAL: [illegible] increase to [illegible] megawatts capacity Major Regional Aspects 1) Major increases in all Electric Utility Regions 2) Electric Utility Region 1 - [illegible] increase to [illegible] MW capacity 3) Electric Utility Region 3 - [illegible] increase to [illegible] MW capacity 4) Electric Utility Region 9 - [illegible] increase to [illegible] MW capacity	Identical to EIA	Identical to EIA	Identical to EIA	Identical to EIA	Identical to EIA
NUCLEAR POWER PLANTS	NATIONAL: [illegible] increase to [illegible] tons U-235 Major Regional Aspects 1) Large increases in all Electric Utility Regions 2) Electric Utility Region 1 - [illegible] increase to [illegible] tons U-235 3) Electric Utility Region 7 - [illegible] increase to [illegible] tons U-235 4) Electric Utility Region 9 - [illegible] increase to [illegible] tons U-235	Identical to EIA	Identical to EIA	Identical to EIA	Identical to EIA	Identical to EIA

COAL SUPPLY REGIONS   PETROLEUM SUPPLY REGIONS


5
7
3
1
6
2
4
2
4
2A
10
7
9
3
11A
5
6
11
1
6A

PETROLEUM REFINERY (PAD) REGIONS   ELECTRIC UTILITY REGIONS

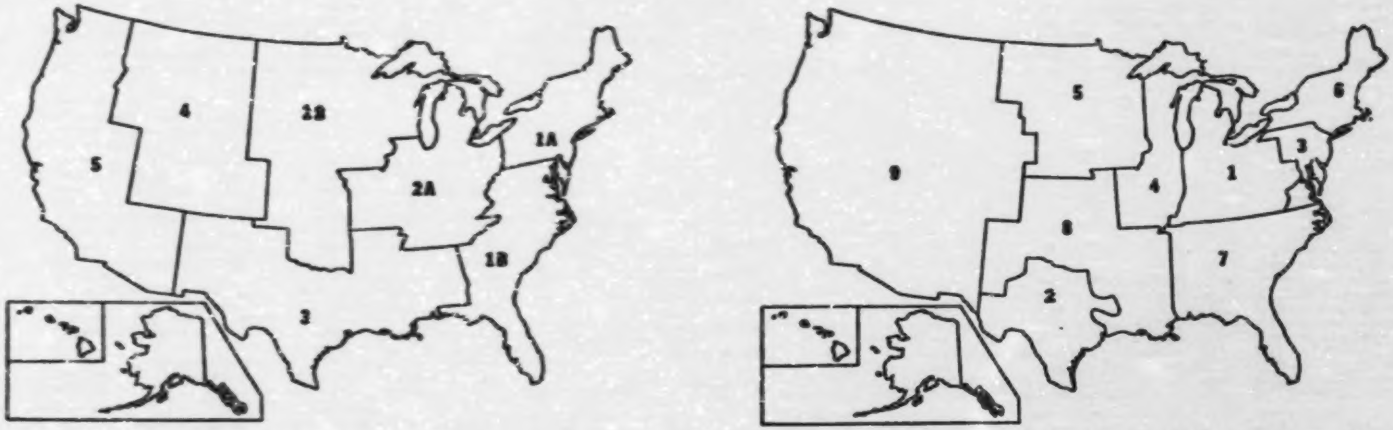

4
2B
1A
5
2A
1B
3
5
6
9
3
4
1
8
7
2

FIGURE 6-1

KEY TO SUPPLY, REFINERY, AND UTILITY REGIONS

TABLE 6-3

COMPARISON OF NATIONAL POLLUTION LOADINGS OF ENERGY INDEPENDENCE ACT WITH OTHER SCENARIOS IN 1985

POLLUTANT[a]	ENERGY INDEPENDENCE ACT (EIA)	BUSINESS AS USUAL (BAU) % BAU GREATER THAN EIA	ACCELERATED SUPPLY (AS) % AS GREATER THAN EIA	ACCELERATED CONSERVATION (AC) % AC GREATER THAN EIA	REDUCED SUPPLY (RS) % RS GREATER THAN EIA	REDUCED CONSERVATION (RC) % RC GREATER THAN EIA
Total Dissolved Solids (100 tons/day)	58.4	3	-2	-3	-1	3
Suspended Solids (tons/day)	305	-8	7	-1	-1	-8
Organics (100 tons/day)	1.84	-26	8	-1	-26	1
Thermal (billion Btu/day)	27100	-3	-7	-1	-1	0
Particulates[b] (tons/day)	8970	8	-7	-2	-1	10
Nitrogen Oxides[b] (tons/day)	63300	-1	-3	-2	-2	1
Sulfur Oxides[b] (tons/day)	96600	-6	-3	-14	-2	-4
Hydrocarbons[b] (tons/day)	26300	9	0	-4	-8	19
Carbon Monoxide[b] (tons/day)	68400	24	-8	-4	0	23
Solids (1000 tons/day)	1010	-52	10	-1	0	-12
Fixed Land (100 acres)	357000	0	0	0	0	0
Maximum Incremental Land (100 acres)	25400	-24	18	-1	-3	-26

[a] Acids, Bases and Aldehydes are not included.

[b] Includes loadings from the end-use of energy.

An acceptable weighting scheme has not yet been developed. However, the loadings associated with both the AC and RS scenarios are dominated by the EIA's. Total dissolved solids and suspended solids are at low levels and comparable for all scenarios (see Figure 6-2) and probably should be weighted less heavily than the other residuals. Thus, BAU appears to impact water and land less adversely than EIA, but impacts air more severely (unless heavy consideration is given to oxides of sulfur and nitrogen). The reverse is true for AS which is inferior to EIA for water and land, but clearly superior for air. RC is substantially superior to EIA for land impacts, perhaps equal for water and probably inferior for air (unless a very heavy weight is attached to oxides of sulfur).

Table 6-4 gives a national and regional breakdown of the loadings for each scenario. It shows that:

- Due to differences in underground coal production among EIA, BAU, AS and RC, there are corresponding changes in maximum incremental land (land subsidence) and solids (mine wastes) among the scenarios. These changes occur mainly in Demand Regions 2, 3, 4, 5 and 6 (Mid-Atlantic, South Atlantic, East North Central, East South Central and West North Central).

- Because natural gas production is 20 percent greater under RC than EIA there are higher hydrocarbon loadings under RC, especially in Demand Regions 7 and 8 (West South Central and Mountain).

- Since oil production varies among EIA, BAU, AS and RS, there are corresponding differences in organic loadings for those scenarios. The differences occur mostly in Demand Regions 3, 9 and 10 (South Atlantic, Pacific and Alaska).

- Despite the differences in the distribution of fossil fuel-fired electricity generation and refining activity among scenarios, most of the effects are negligible. However, NO(x), SO(x) and solids loadings are noticeably lower under BAU and RC than under EIA where the effects do not quite balance. The differences occur mainly in Demand Regions 2, 4, 6 and 8 (Mid-Atlantic, East North Central, West North Central and Mountain).

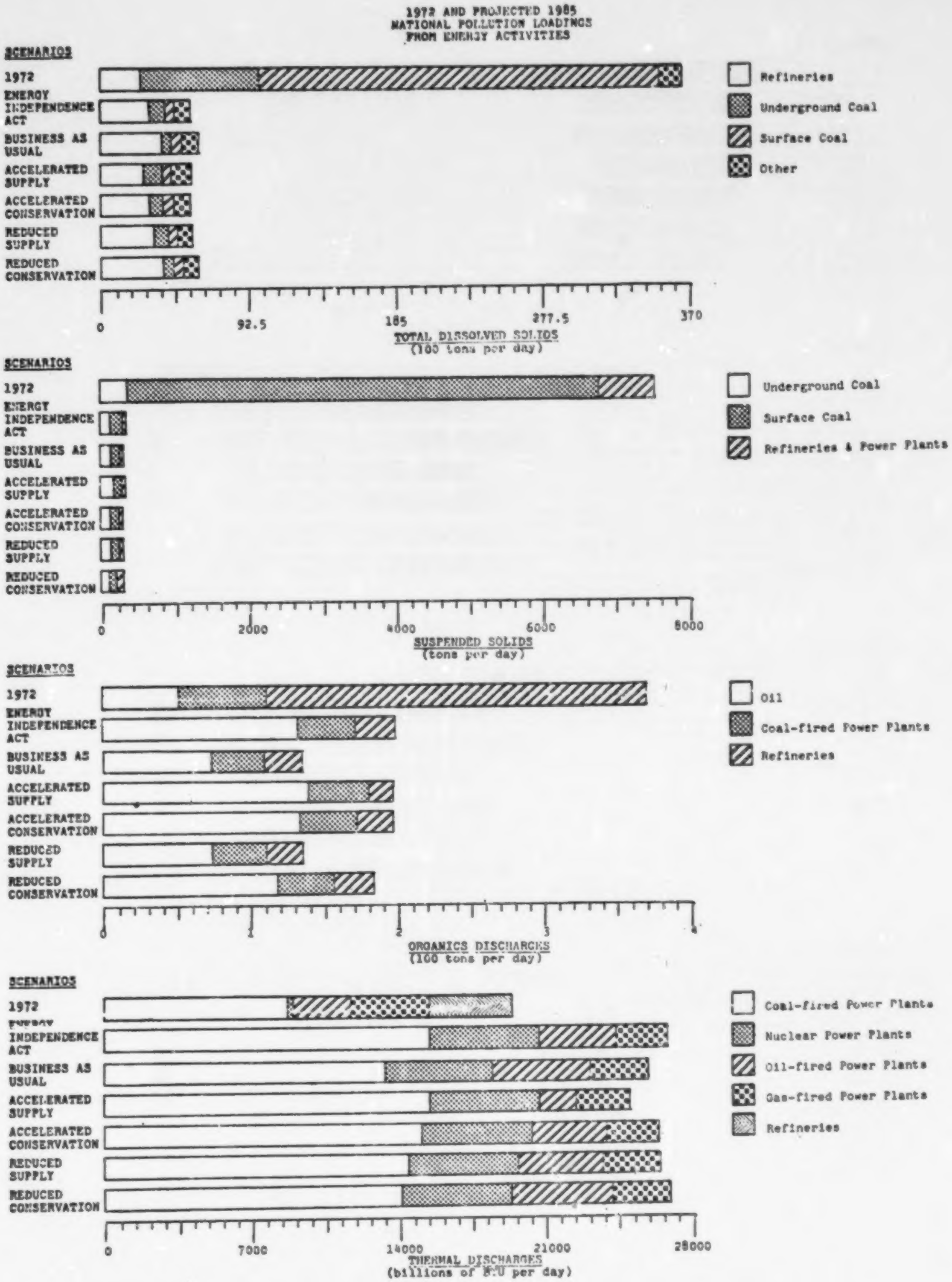
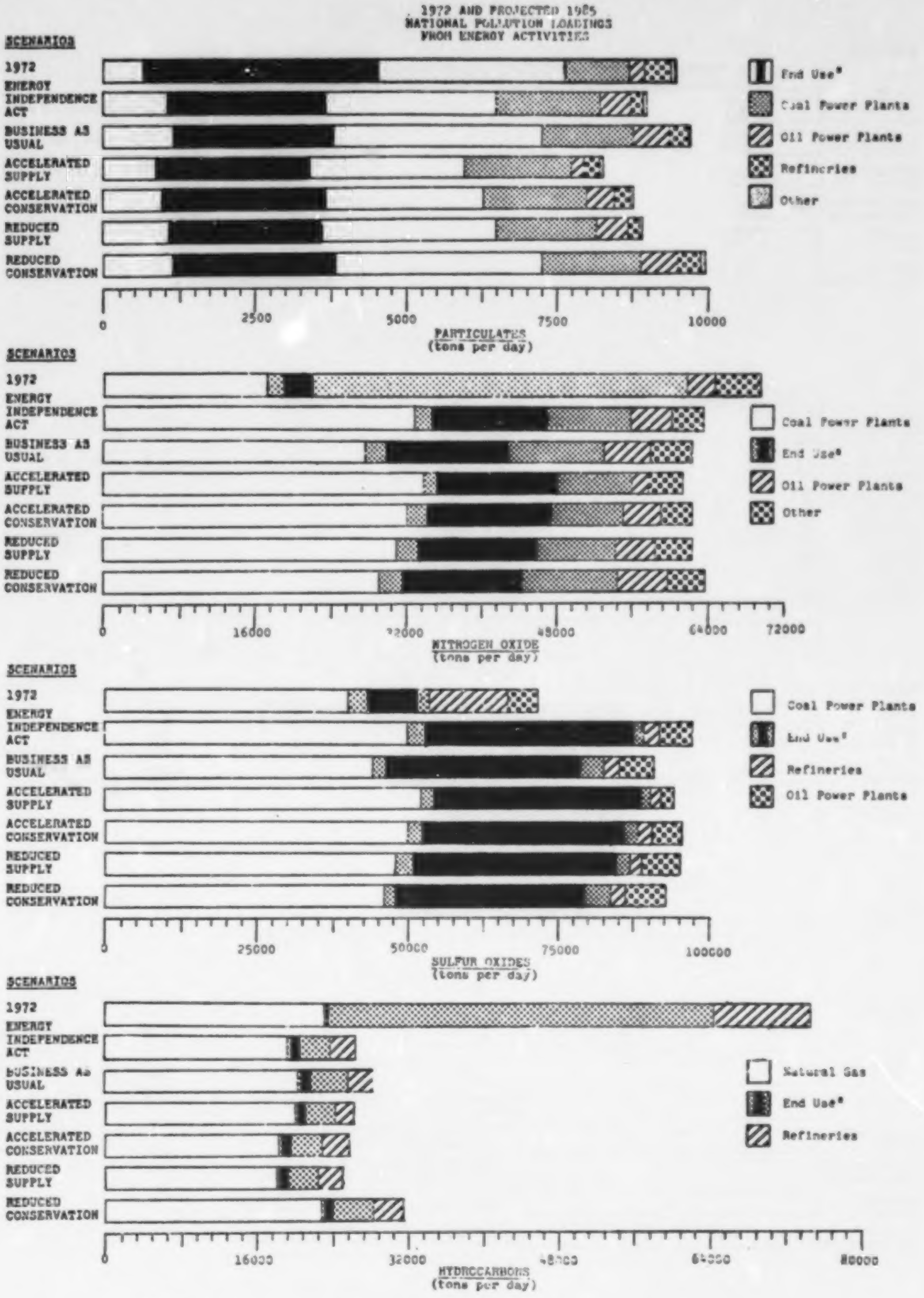


FIGURE 6-2

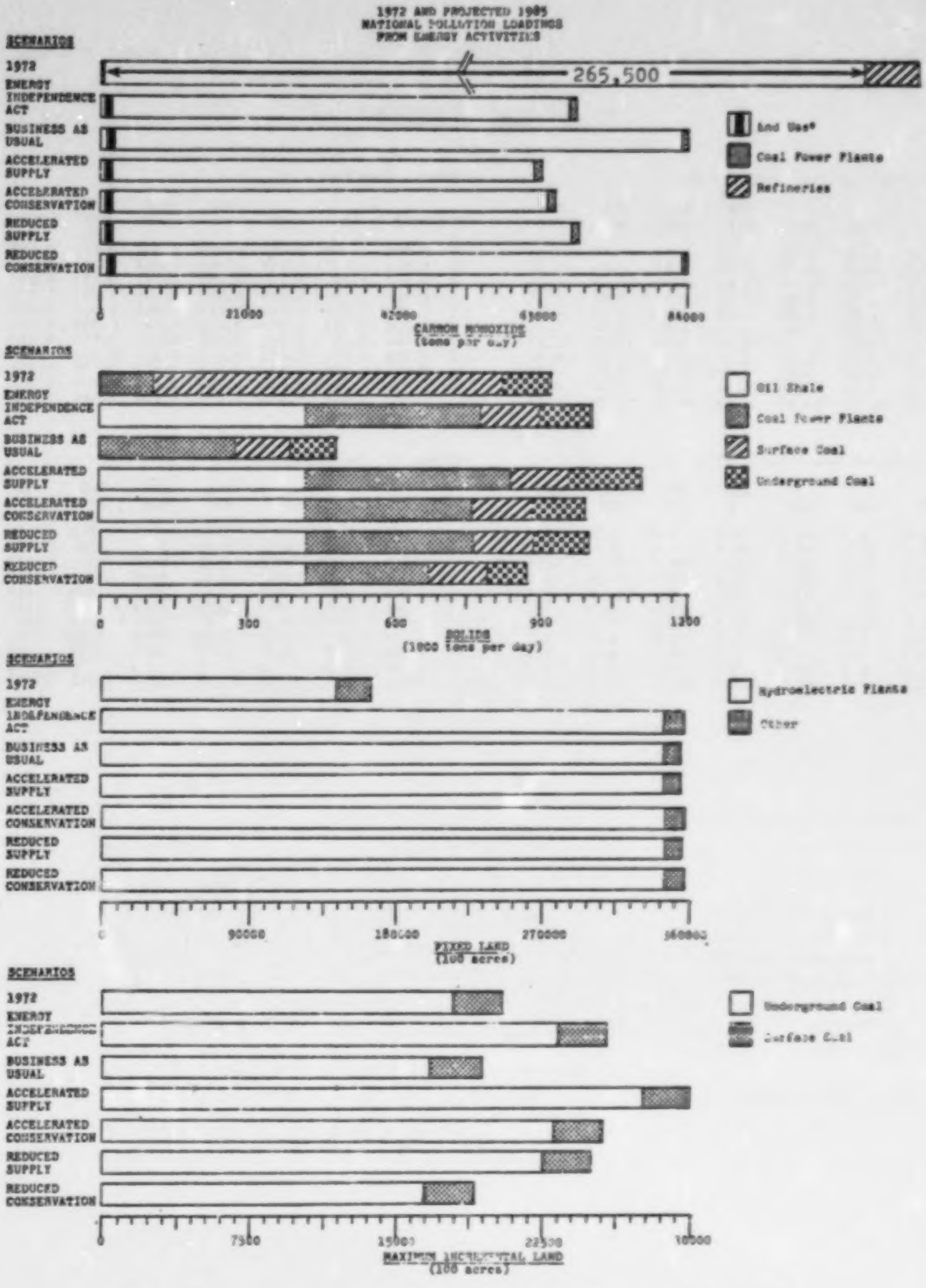
1972 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES



* 123 End Use is divided into 1) Household/Commercial, 2) Industrial and 3) Transportation.

FIGURE 6-2 (CONT.)

1972 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES



* 123 End Use is divided into 1) Household/Commercial, 2) Industrial and 3) Transportation.

FIGURE 6-2 (CONT.)

1972 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES

TABLE 6-4

POLLUTION LOADINGS

TOTAL DISSOLVED SOLIDS (100 tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	0.25	0.44	0.39	0.30	0.43	0.44	0.33
2	15.20	6.44	6.14	7.08	6.41	6.45	6.10
3	23.89	17.00	20.08	13.41	16.29	17.01	19.80
4	161.62	8.73	9.03	10.62	8.68	8.47	8.84
5	95.98	4.97	4.85	5.25	4.89	4.92	4.82
6	18.12	2.93	1.90	3.14	2.88	2.74	1.83
7	22.22	10.31	10.12	9.94	9.78	10.36	10.21
8	27.16	3.23	2.44	2.16	3.17	3.20	2.88
9	5.17	4.22	5.35	5.17	4.08	4.25	5.39
10	0.14	0.10	0.13	0.13	0.10	0.10	0.13
TOTAL	369.75	58.38	60.41	57.18	56.72	57.94	60.34

ORGANICS (100 tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	0.003	0.047	0.005	0.051	0.047	0.005	0.048
2	0.303	0.061	0.052	0.063	0.061	0.061	0.060
3	0.268	0.245	0.167	0.231	0.242	0.164	0.253
4	0.566	0.109	0.120	0.097	0.108	0.102	0.122
5	0.205	0.066	0.068	0.061	0.065	0.065	0.069
6	0.205	0.062	0.053	0.053	0.061	0.058	0.053
7	1.464	0.644	0.558	0.658	0.638	0.563	0.642
8	0.179	0.085	0.063	0.075	0.084	0.072	0.080
9	0.491	0.371	0.191	0.358	0.371	0.186	0.376
10	0.017	0.298	0.089	0.330	0.298	0.089	0.147
TOTAL	3.701	1.989	1.366	1.977	1.976	1.364	1.850

SUSPENDED SOLIDS (tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
2	1160.7	28.5	26.9	31.7	28.5	28.5	26.9
3	1740.2	95.8	95.5	105.4	94.3	96.5	95.7
4	1510.4	78.0	65.2	88.8	77.7	75.5	63.4
5	2695.4	56.5	53.5	58.8	56.1	56.1	53.1
6	55.2	14.6	9.3	14.7	14.5	13.9	8.7
7	231.0	20.5	20.2	18.3	19.4	20.3	20.1
8	82.3	2.6	1.5	1.4	2.6	2.6	2.6
9	100.6	8.1	9.3	5.7	8.1	8.2	9.3
10	2.7	0.3	0.3	0.2	0.3	0.3	0.3
TOTAL	7580.8	304.9	281.6	325.1	301.5	301.9	280.0

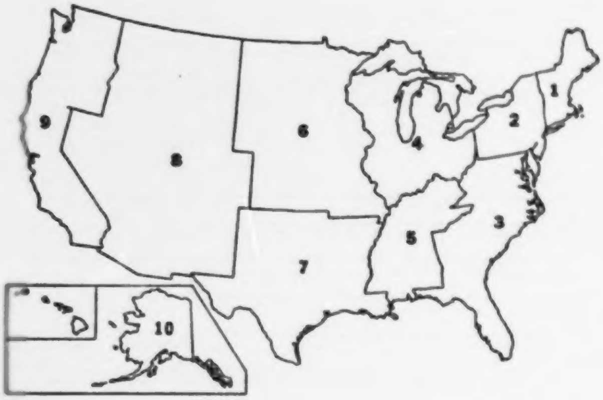
THERMAL (E9 Btu/day)[b]

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	1034	1118	1571	831	1111	1119	1641
2	1552	2269	2233	2373	2248	2264	2422
3	3999	6231	6088	5237	6166	6304	6183
4	3338	4569	4292	4667	4543	4461	4355
5	2000	3064	3021	3001	3031	3023	3054
6	1259	2069	1843	2060	2009	1925	1865
7	3671	3844	3737	3665	3844	4015	3875
8	984	2901	2319	2505	2858	2559	2597
9	1732	996	1071	1001	992	1018	1172
10	17	0	0	0	0	0	0
TOTAL	19590	27065	26178	25344	26806	26692	27167

[a] DEMAND REGION INDEX

1) North East
2) Mid-Atlantic
3) South-Atlantic
4) East North Central
5) East South Central
6) West North Central
7) West South Central
8) Mountain
9) Pacific
10) Alaska

[b] E9 is one billion



DEMAND REGIONS

TABLE 6-4 (CONT.)

POLLUTION LOADINGS

PARTICULATES (tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	68.8	60.2	96.5	37.4	59.5	60.3	95.9
2	162.2	220.8	213.9	241.8	217.8	220.3	240.6
3	427.0	702.5	725.4	521.4	685.2	702.3	737.0
4	378.8	459.3	454.1	468.3	456.2	436.1	456.8
5	234.1	269.5	266.4	262.5	265.0	263.9	269.5
6	112.0	220.1	190.3	220.1	212.8	201.0	190.5
7	243.8	289.1	267.0	271.6	284.3	300.6	289.0
8	75.4	237.4	132.3	207.3	234.6	216.9	221.0
9	111.0	74.6	90.5	79.6	73.1	73.1	97.0
10	2.2	2.8	2.3	3.0	2.7	1.2	3.0
TOTAL	1815.4	2536.3	2438.8	2313.1	2491.2	2475.8	2600.1

NO(X) (tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	947	1025	1322	661	1014	1027	1286
2	1837	3680	3225	4340	3611	3680	3465
3	6313	8838	8692	8000	8676	8852	8851
4	5180	7415	6511	7887	7350	7015	6552
5	3516	4396	4288	4480	4327	4316	4323
6	1627	3596	3034	3600	[illegible]	3254	3064
7	2591	4696	4330	4467	4648	4955	4696
8	1379	5838	4589	5011	5734	5227	5080
9	1122	964	1061	988	947	956	1162
10	10	38	27	39	37	12	38
TOTAL	24525	40490	37082	39478	39809	39298	38520

SO(X) (tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	1784	1007	1349	694	995	1009	1280
2	5155	4528	4088	5278	4461	4505	4612
3	15657	14755	14517	13195	14502	14587	14885
4	14307	13817	12211	14176	13704	12811	12375
5	9015	8042	7876	7895	7916	7860	7969
6	3909	6889	5885	6864	6629	6200	5930
7	5144	5292	4261	4935	5254	5594	5129
8	1346	2359	1856	2081	2310	2256	2013
9	2571	768	904	725	756	758	970
10	54	6	8	6	6	6	8
TOTAL	58945	57467	52960	55857	56538	55591	55174

HYDROCARBONS (tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	16	65	36	55	65	29	129
2	1104	348	337	351	346	344	340
3	559	1434	1687	1134	1325	1462	1871
4	1675	745	844	799	744	707	882
5	491	186	191	191	183	179	195
6	1428	1057	957	1062	1055	994	1047
7	22716	12504	15394	13317	11847	13609	15326
8	2809	2590	1753	2128	2588	1432	3115
9	2179	762	897	829	752	728	998
10	171	2247	1397	2249	2168	1222	2169
TOTAL	33153	21944	23498	22120	21079	20712	26081

CARBON MONOXIDE (tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	26.1	46.3	50.9	24.7	45.7	46.4	44.6
2	797.3	147.8	116.5	172.1	143.3	148.7	113.4
3	444.8	293.8	282.8	277.5	287.6	296.1	283.6
4	1251.8	251.1	211.6	277.8	248.2	240.1	206.6
5	356.0	136.6	131.4	150.9	134.7	135.3	130.7
6	469.0	107.7	86.3	108.6	102.6	96.3	86.5
7	2899.3	120.7	110.8	113.7	120.4	137.4	119.9
8	352.4	225.0	188.4	205.2	219.4	221.2	183.3
9	1272.5	30.4	32.0	29.2	29.9	30.0	33.6
10	31.1	0.1	0.1	0.2	0.1	0.1	0.2
TOTAL	7900.4	1359.5	1211.0	1359.9	1331.9	1351.5	1202.4

SOLIDS (1000 tons/day)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	0.5	21.5	13.8	12.4	21.2	21.5	8.6
2	160.7	94.0	69.5	119.3	91.2	94.8	62.9
3	236.7	135.2	125.7	176.3	132.9	136.6	124.3
4	224.0	147.4	109.1	177.8	146.1	141.9	103.8
5	287.2	84.9	79.0	99.2	84.0	84.5	77.2
6	9.5	40.3	29.5	42.3	38.9	36.4	29.2
7	2.1	17.8	13.5	17.3	17.8	21.0	16.9
8	6.7	467.5	42.5	463.6	466.2	467.2	457.7
9	1.0	3.7	3.4	3.6	3.6	3.7	3.3
10	0.2	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL	928.5	1012.4	486.2	1112.0	1001.8	1007.8	884.0

FIXED LAND (100 acres)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	2357	17071	17104	16976	17069	17066	17089
2	11115	31436	31328	31506	31419	31439	31310
3	5187	27122	27443	26502	27025	27130	27423
4	2428	14057	14144	14242	14048	14036	14114
5	10200	35429	35423	35488	35418	35426	35419
6	15921	24786	24655	24803	24771	24747	24651
7	15474	8833	8853	8992	8755	8904	8908
8	30503	52993	52786	52863	52972	52950	52866
9	64482	143878	143966	143979	143861	143826	144030
10	340	1212	760	1218	1210	728	1199
TOTAL	158012	356821	356495	356574	356552	356257	357012

MAXIMUM INCREMENTAL LAND (100 acres)

DR[a]	1972	EIA	BAU	ACC SUP	ACC CON	RED SUP	RED CON
1	0	0	0	0	0	0	0
2	3082	1630	1630	2041	1630	1630	1630
3	7750	5695	5616	6813	5579	5760	5579
4	3316	10161	6176	12305	10079	9545	5765
5	4993	4852	4091	5279	4812	4751	4007
6	61	2172	1164	2582	2150	2016	1060
7	123	347	237	374	346	388	275
8	412	534	441	525	529	529	511
9	28	11	11	11	11	11	11
10	6	3	3	3	3	3	3
TOTAL	19774	25408	19372	29936	25141	24637	18843

Figures 6-3 through 6-8 display areas where primary standards for SO(x) and particulates were violated in 1972 and where there would be increased loadings in 1985. Table 6-5 compares land area and population among scenarios in regions that violated primary standards in 1972 and that show increased energy-associated loadings in 1985 for SO(x) and particulates. The maps and table demonstrate that Reduced Conservation and EIA will produce more air pollutants than the other three scenarios in regions with existing air pollution problems.

Although national pollution loadings increase only slightly or actually decline under all of the scenarios when compared to 1972 (see Figure 6-2), some regions of the country will experience relatively higher pollution loadings or greater changes from 1972 than other regions. Three regions -- Southeast, Mountain States and Alaska -- will experience significantly greater change than the rest.

In the Southeast, all energy activities, except natural gas-fired power plants, increase substantially under all scenarios. Surface coal mining, oil production and refinery production increase by especially large amounts.

In the Mountain States, both the extraction of oil shale and a very large increase in surface coal production cause heavy pollution loadings.

A large portion of the national oil production occurs in Alaska (as much as 37 percent). Thus Alaska will experience very large increases in pollutants resulting from oil production.

In the PIES Model, it was assumed that new facilities would employ more effective pollution abatement technology than existing facilities. Thus, for example in Demand Region 8 (Mountain Region), the EIA and Reduced Supply scenarios both predict about 450,000 tons of coal per day for coal-fired electricity generation. However, EIA shows higher loadings of pollutants associated with coal-fired power plants (thermal, particulates, NO(x), SO(x) and CO, than Reduced Supply. This results from the fact that EIA predicts 56 percent old plants while RS predicts 45 percent old plants. The major differences in production levels between old and new plants are confined to Demand Region 8.

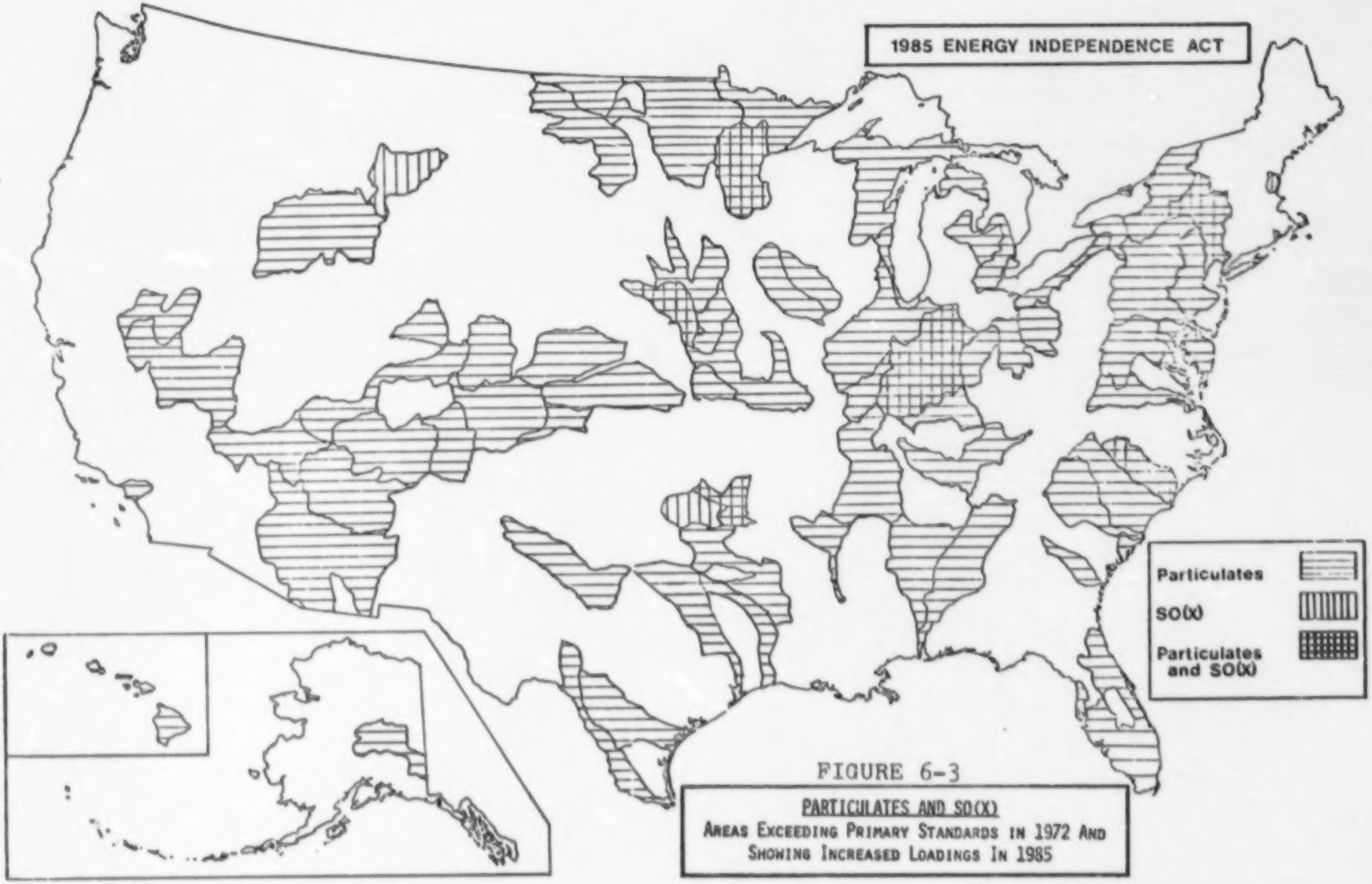

1985 ENERGY INDEPENDENCE ACT
Particulates ▤
SO(X) ▥
Particulates and SO(X) ▦

FIGURE 6-3

PARTICULATES AND SO(X)

AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

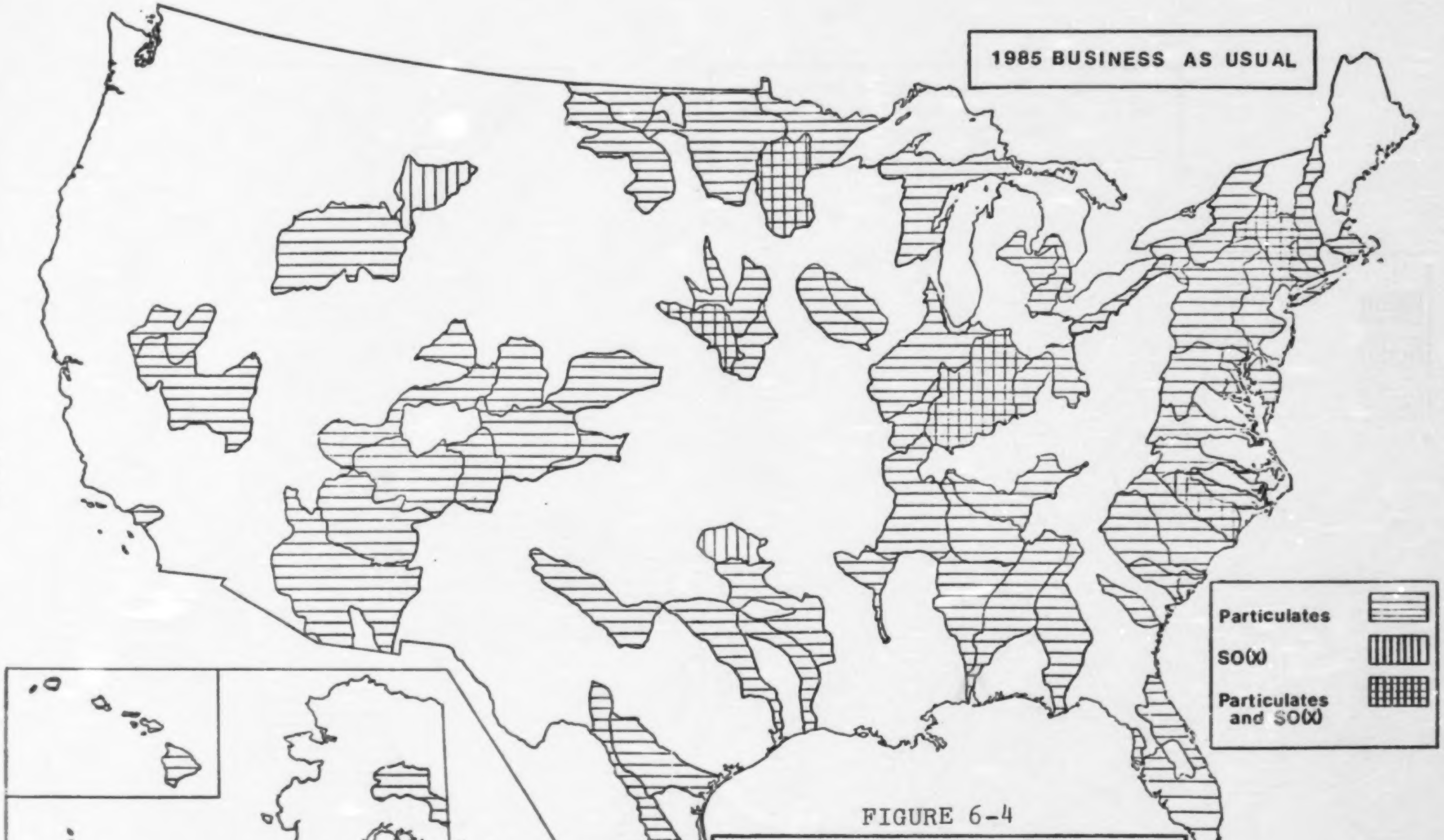

1985 BUSINESS AS USUAL
Particulates ▤
SO(X) ▥
Particulates and SO(X) ▦

FIGURE 6-4

PARTICULATES AND SO(X)

AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

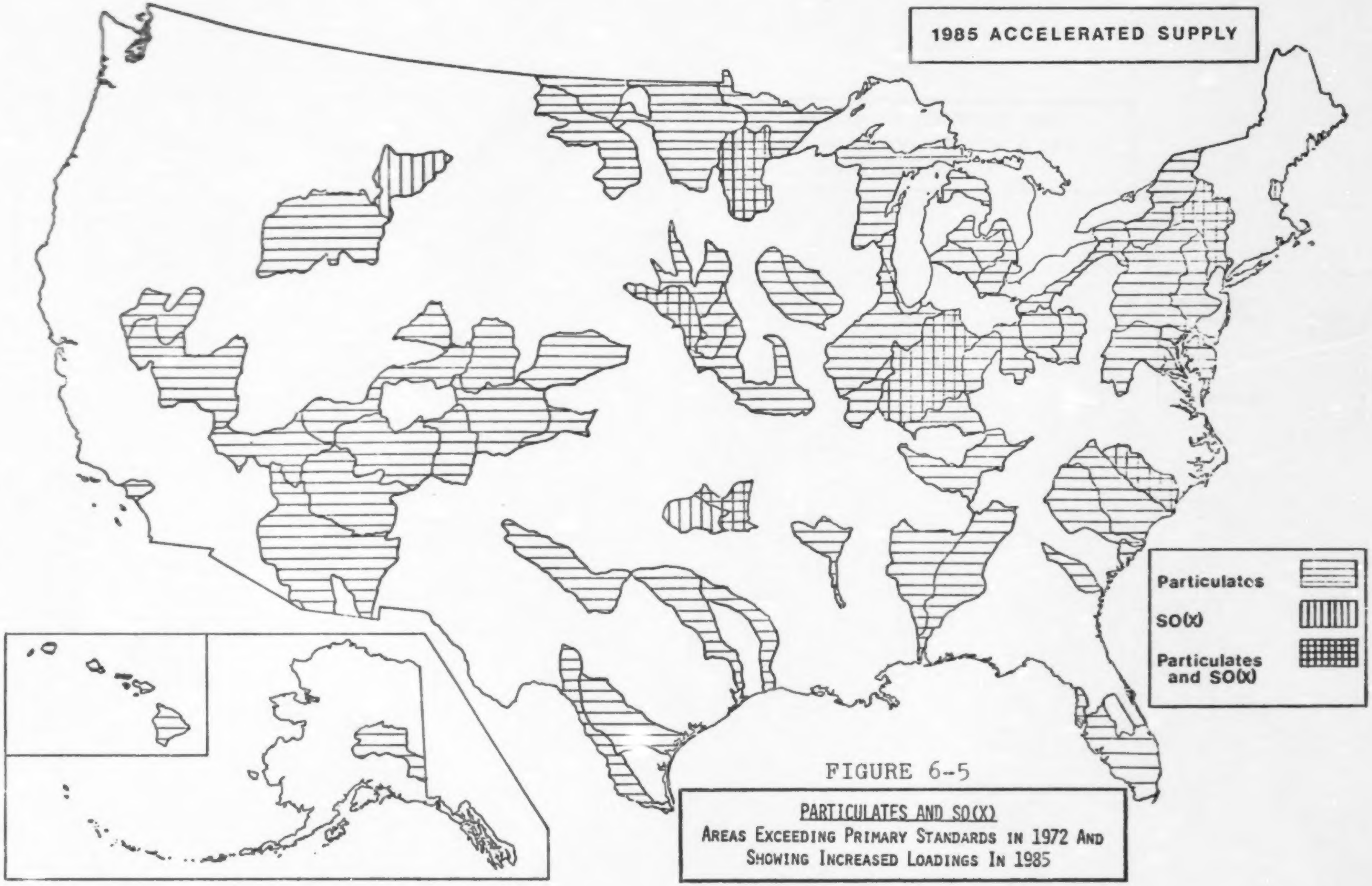

1985 ACCELERATED SUPPLY
Particulates
SO(X)
Particulates and SO(X)

FIGURE 6-5

PARTICULATES AND SO(X)

AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

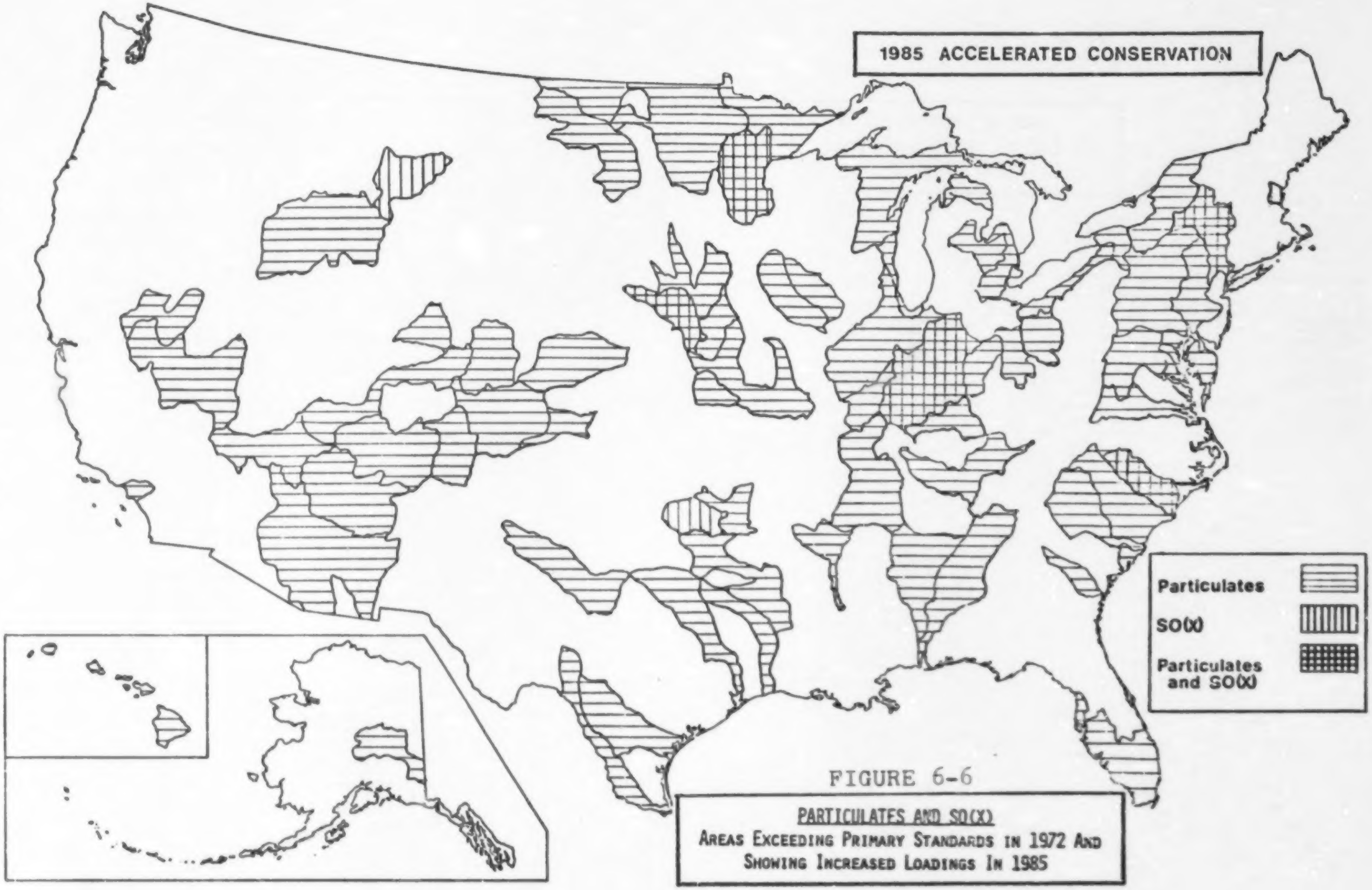

1985 ACCELERATED CONSERVATION
Particulates
SO(X)
Particulates and SO(X)

FIGURE 6-6

PARTICULATES AND SO(X)

AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

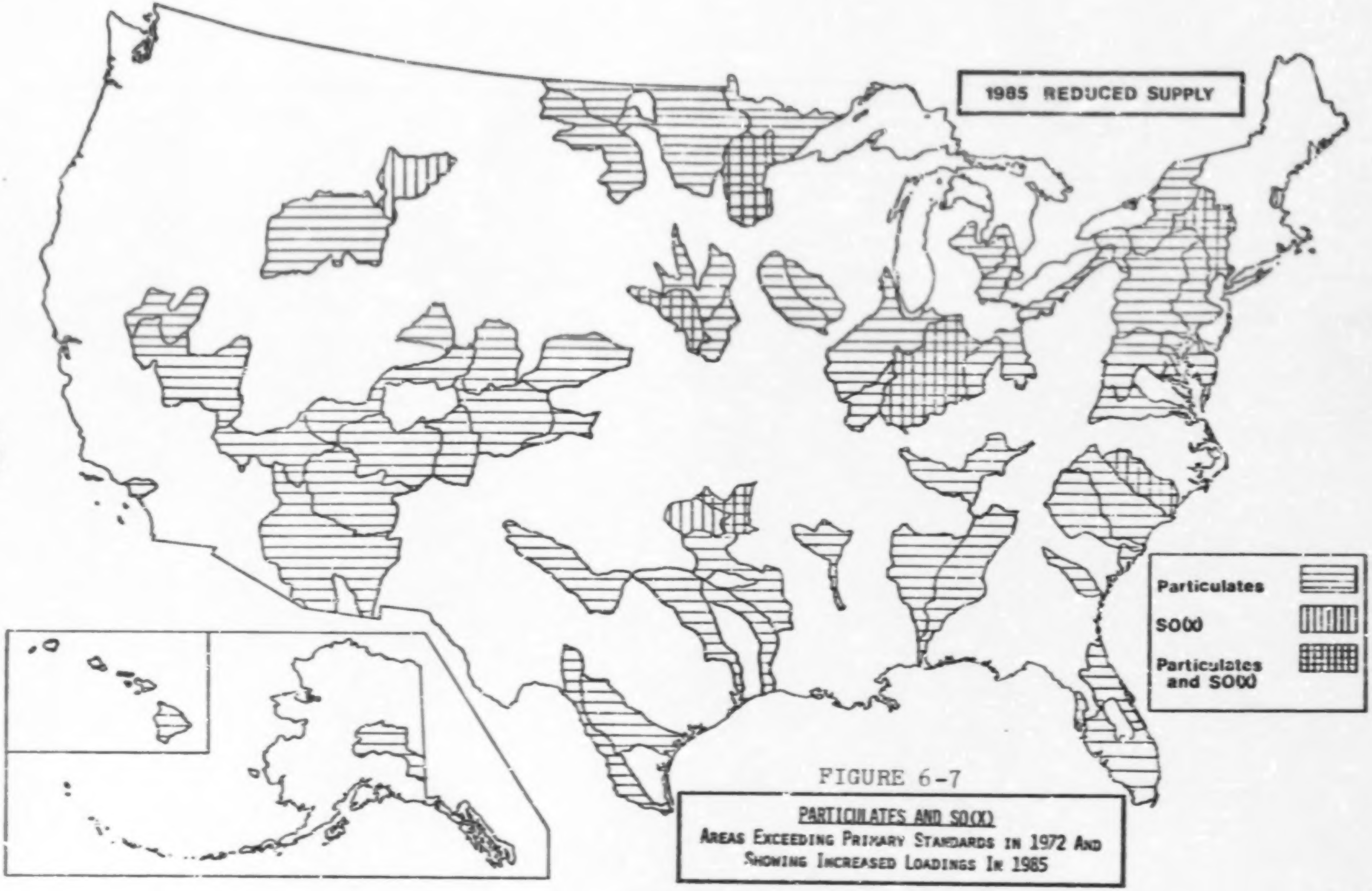

1985 REDUCED SUPPLY
Particulates ▤
SO(X) ▥
Particulates and SO(X) ▦

FIGURE 6-7

PARTICULATES AND SO(X)

Areas Exceeding Primary Standards In 1972 And Showing Increased Loadings In 1985

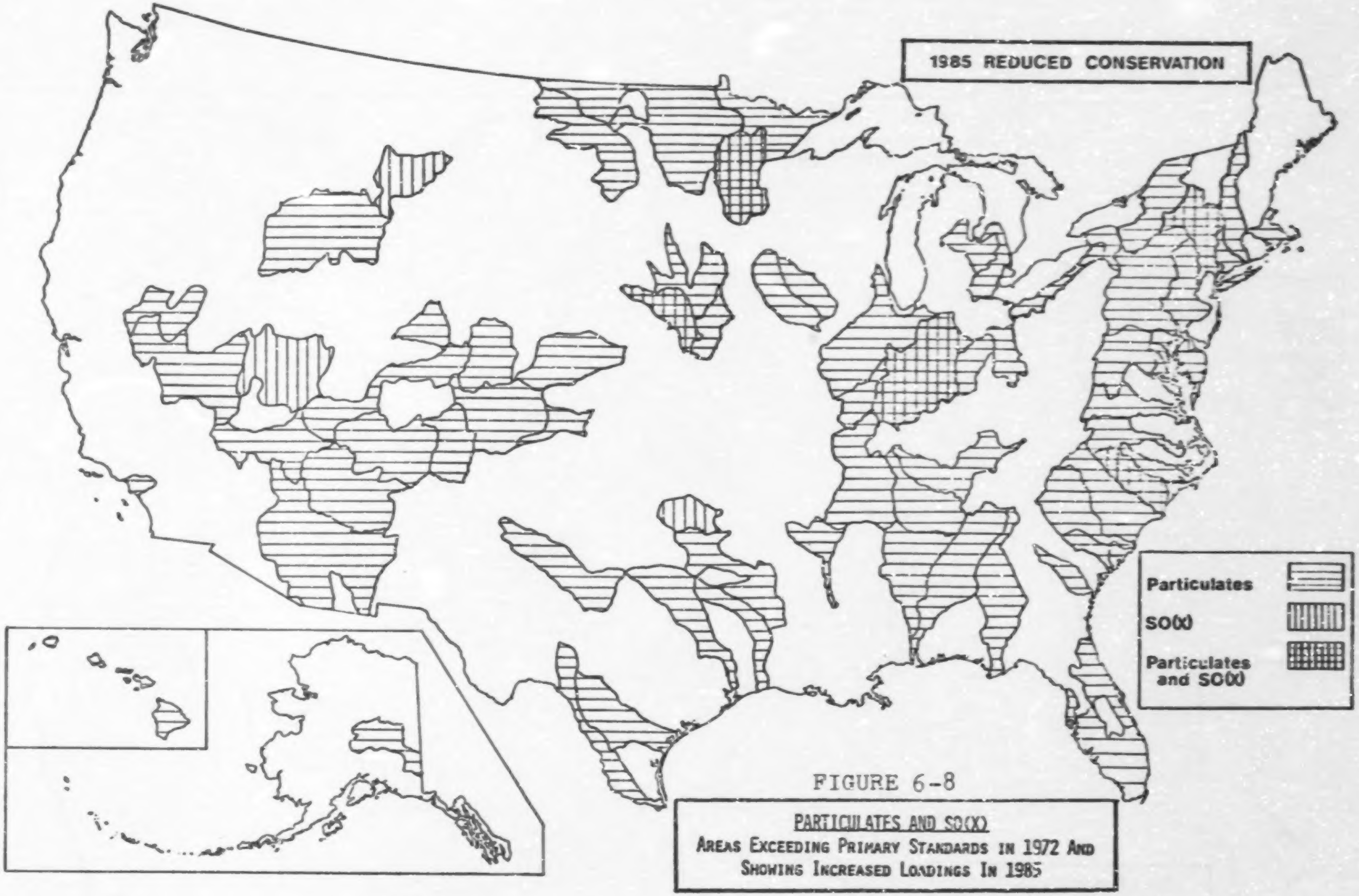

1985 REDUCED CONSERVATION
Particulates
SO(X)
Particulates and SO(X)

FIGURE 6-8

PARTICULATES AND SO(X)

AREAS EXCEEDING PRIMARY STANDARDS IN 1972 AND SHOWING INCREASED LOADINGS IN 1985

TABLE 6-5

ENERGY INDEPENDENCE ACT VS. OTHER SCENARIOS COMPARISON BY LAND AREA AND POPULATION[a]

	PARTICULATES		SO(X)	
	AREA (sq. miles)	POPULATION (1000)	AREA (sq. miles)	POPULATION (1000)
Energy Independence Act (EIA)	1,059,900	85,180	113,500	11,050
Business As Usual greater than EIA (%)	-9	8	0	0
Accelerated Supply greater than EIA (%)	-10	-5	0	0
Accelerated Conservation greater than EIA (%)	-3	-2	0	0
Reduced Supply greater than EIA (%)	-12	-17	-17	-16
Reduced Conservation greater than EIA (%)	-6	8	20	-1

[a] In regions violating primary standards in 1972 and showing increased loadings in 1985 for SO(X) and particulates.

Predicted radiation loadings for each 1985 scenario are shown in Table 6-6. These loadings are based on the assumption of "normal" operation (i.e., no nuclear accidents) and compliance with all radiation standards.[1,2] Table 6-7 presents loadings of non-radioactive pollutants from the entire uranium fuel cycle except nuclear power plants. These loadings are those predicted for mining, milling, uranium hexaflouride production, fabrication, reprocessing and waste disposal. All scenarios predict the same amount of nuclear development so there are no differences among the scenarios.

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[1] U.S. Atomic Energy Commission, Survey of Uranium Fuel Cycle, April 1974.

[2] U.S. Environmental Protection Agency, Environmental Analysis of the Uranium Fuel Cycle, October 1973.

TABLE 6-6

PREDICTED RADIATION LOADINGS[a]

NUCLEAR POWER PLANTS Electric Utility Region	U-235 (tons/day)	MEDIUM Air (curies/day)	Water (curies/day)	Solids (curies/day)
1	.066	79.988	19.079	0
2	.024	29.086	6.938	0
3	.077	94.531	22.548	0
4	.066	79.988	19.079	0
5	.012	14.543	3.468	0
6	.072	87.259	20.814	0
7	.185	225.42	53.768	0
8	.030	36.358	8.672	0
9	.066	79.988	19.079	0
Total From Power Plants	Used .598	727.162	173.446	0
Uranium Fuel Cycle Except Power Plants	Produced .598	177022.171	1203.989	290.269
National Total	-	177749.333	1377.435	290.269

[a] Radioactivity from the wastes of nuclear power plants stored in nuclear waste disposal facilities is *not* included.

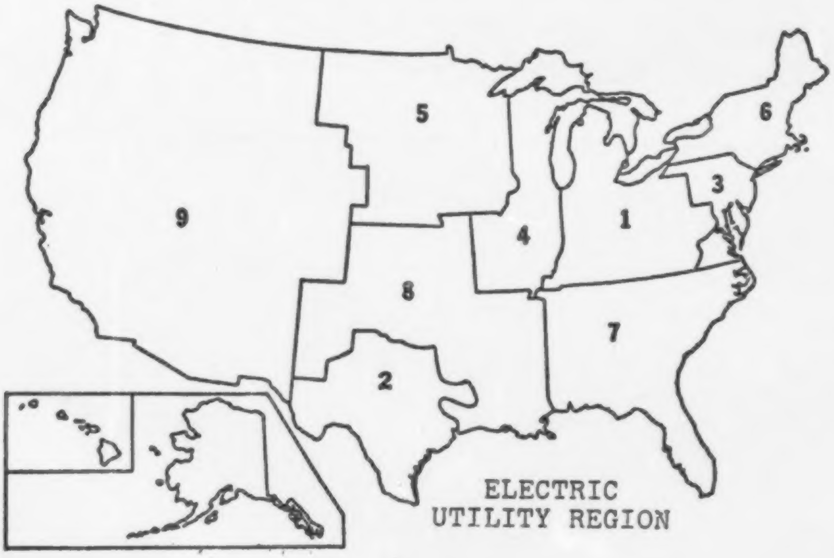

TABLE 6-7

POLLUTION LOADINGS FROM URANIUM FUEL CYCLE

(Except Nuclear Power Plants)

POLLUTANTS	ALL SCENARIOS
Acids (tons/day)	0.000
Bases (tons/day)	0.000
TDS (100 tons/day)	0.494
SS (tons/day)	0.000
Organics (100 tons/day)	0.000
Thermal (E9 Btu/day)	0.000
Particulates (tons/day)	3.195
NO(x) (tons/day)	14.364
SO(x) (tons/day)	15.974
HC (tons/day)	1.222
CO (tons/day)	0.107
Aldehydes (tons/day)	0.383
Solids (1,000 tons/day)	46.398
Fixed Land (100 acres)	1,015.970
Max. In. Land (100 acres)	0.000

CHAPTER SEVEN

NATIONAL ENERGY OUTLOOK

7.1 Description of Scenarios

FEA provided Environment Reports and PIES Model Reports of the following scenarios for analysis.

- REF -- 1985 Reference Case -- $13 for imported oil (FEA # 85BAU6A, DB51215, DEC15-1)
- BAU/C -- 1985 Business-as-Usual with Conservation -- $13 for imported oil (FEA # 85BAU6A, DC51215, DEC15-1)
- AS/C -- 1985 Accelerated Supply with Conservation -- $13 for imported oil (FEA # 85ACC6A, DC51215, DEC15-1)
- ELEC -- 1985 Electrification Case -- $13 for imported oil (FEA # 85ELC6A, DE51215, DEC15-2)
- REG/LIM -- 1985 Regional Limitation -- $13 for imported oil (FEA # 85LIM6C, DB51215, JAN31)
- EAC -- 1985 Environmental Advisory Committee -- $13 for imported oil (FEA # 85BAU, DC51215, APR28-1)

7.2 Major Energy Features

There are two main components that contribute to the levels of residuals: consumption and supply of energy. (In this model power generation is considered a supply activity with electricity use considered the corresponding consumption mode. The extraction of raw material to fuel a power plant is also a supply activity.) Before the National Energy Outlook end use was not part of the PIES model and no analysis of residuals from energy consumption was performed (except at a national level for the Energy Independence Act). Now that an end use model is available an evaluation of the environmental impacts due to the demand sector has yielded some interesting results especially concerning the relative impact of consumption to the entire fuel cycle and the effect of conservation on the supply of energy. Comparison of the national energy activities for each scenario to the Reference case shows in general that:

- REG/LIM is essentially the same as REF;
- BAU/C (about 10 percent), AS/C (about 6 percent) and EAC (about 20 percent) have substantially lower end-use fuel consumption than REF;
- ELEC has nearly the same end-use consumption as REF, but much heavier use of coal is made for industry;
- ELEC is characterized by high levels of coal use in each aspect of the fuel cycle;
- AS/C has more domestic petroleum production than REF and no imported crude oil; and
- EAC has substantially lower supply activity levels than REF.

More specific examination shows several significant differences (more than 10 percent) as listed below:

- Surface coal production is 30 percent greater under ELEC and 26 percent less under EAC than under REF;
- Oil production is 17 percent greater under AS/C than under REF;
- High Btu gasification is 200 percent greater under AS/C and ELEC than under REF; there is none in EAC;
- Coal-fired electricity generation is 12 percent greater under ELEC and 14 percent less under EAC than under REF;
- Oil-fired electricity generation is 28 percent less under BAU/C and EAC and 36 percent less under AS/C and ELEC than under REF;

- Gas-fired electricity generation is 28 percent greater under EAC, 22 percent greater under BAU/C and 16 percent greater under AS/C than under REF;
- Electricity generation from turbines is 90 percent less under AS/C, 14 percent greater under BAU/C, 26 percent greater under EAC and 38 percent greater under REG/LIM than under REF;
- Nuclear power generation is 14 percent greater under ELEC and 38 percent less under EAC than under REF;
- Refining activity is 13 percent less under BAU/C, 16 percent less under AS/C, and 19 percent less under EAC than under REF;
- Oil imports are 16 percent less under ELEC, 33 percent less under BAU/C, 37 percent less under EAC and 70 percent less under AS/C than under REF;
- Industrial coal use is 37 percent greater under ELEC and 18 percent less under EAC than under REF;
- Industrial use of natural gas, distillate and residual oil is between 11 and 17 percent less under EAC than under REF;
- Gasoline fueled transportation is 15 percent less under BAU/C and AS/C and 23 percent less under EAC than under REF;
- Residential/Commercial use of natural gas is 12 percent less under BAU/C and 21 percent less under EAC than under REF;
- Residential/Commercial use of distillate oil is 13 percent less under BAU/C, 15 percent less under AS/C, 23 percent less under EAC and 27 percent less under ELEC than under REF; and
- Residential/Commercial use of residual oil is 18 percent less under ELEC than under REF.

Comparison of the Reference case to 1972 shows:

- A large increase in fuel production including 75 percent more coal; 29 percent more domestic and 24 percent more imported oil; 15 percent more domestic and 3,500 million SCF/day more imported natural gas (in 1972 none was imported); 300,000 Bbl/day of oil from oil shale; and 450 million SCF/day from high Btu coal gasification. Overall this represents about 50 percent more energy production by Btu equivalent than in 1972.
- Refining activity increases by 28 percent.
- Electricity generation more than doubles for all fuels (over 100-fold for nuclear) except oil- and gas-fired which decrease by 14 percent.
- There are large increases of fuel consumption in all end-use sectors. Consumption in the industrial sector more than doubles.

National levels for all activities are shown in Table 7-1. A more detailed analysis is contained in Table 7-2.

7.3 Scenario Analysis

7.3.1 Residuals Comparison

Table 7-3 and Figure 7-2 show the comparison of national pollution loadings for the Reference Case to those of the other scenarios. There are only relatively small variations among all of the scenarios except EAC; however, the ranking of scenarios for each pollutant is fairly consistent (see Table 7-4). BAU/C is superior to REF for all pollutants. AS/C is superior to REF for all pollutants except organics. REF is superior to REG/LIM for all pollutants and both are superior to ELEC for all pollutants save total dissolved solids and hydrocarbons (and the difference is very small for those loadings). BAU/C is slightly better than AS/C for all pollutants except particulates. (There is really little to choose between these last two scenarios.) Finally, EAC is far superior to all scenarios for all pollutants (except BAU/C, maximum incremental land).

TABLE 7-1

NATIONAL ENERGY PRODUCTION UNDER DIFFERENT SCENARIOS

	1972	REF	BAU/CON	AS/CON	ELEC	RPG LIM	EAC	UNITS[a]
Surface Coal	753.887	1610.93	1472.27	1568.67	2097.23	1602.68	1248.81	(E3 tons/day)
Underground Coal	876.791	1032.88	1010.96	1023.03	1054.53	1053.6	1031.8	(E3 tons/day)
Natural Gas	72208.1	61022.8	58948.3	66837.8	58390.5	61247.5	55225.4	(E6 Scf/day)
Oil	9224.29	11949.7	11949.7	13991.9	11949.7	11980.3	11297.8	(E3 bbls/day)
Hi Btu Gasification	0	449.6	449.6	1348.8	1348.8	449.6	0	(E6 Scf/day)
Coal Liquifaction	0	0	0	0	0	0	0	(E3 bbls/day)
Lo Btu Gasification	0	0	0	0	0	0	0	(E6 Scf/day)
Oil Shale	0	300	300	300	300	300	0	(E3 bbls/day)
Power Plants Coal-Fired	314.465	1240.82	1689.34	1654.13	2068.82	1816.92	1579.21	(E3 tons/day)
Oil-Fired	1168.95	999.996	718.96	642.606	649.407	934.8	714.5	(E3 bbls/day)
Gas-Fired	9354.12	8093.04	9855.45	11807.9	8578.59	8210.3	10380	(E6 Scf/day)
Turbines	35.1143	188.686	215.466	20.473	179.189	200.	238.215	(E3 bbls/day)
Nuclear	3.43310E-2	0.4103	0.3992	0.414	0.4735	0.485	0.2975	(tons U-235/day)
Hydroelectric	77.3212	186.963	186.963	186.963	186.963	187.	186.99	(E3 MW)
Refineries	13853.	17742.2	15398.	14901.9	16315.9	18336.	14535.	(E3 bbls/day)
Industrial	18.2229	55.1765	52.3884	55.4833	56.0967	56.8576	48.1014	(E12 Btu/day)
Transportation	54.2335	65.1777	57.9116	58.0337	65.109	65.409	53.2561	(E12 Btu/day)
Residential/Commercial	19.6002	33.1615	29.4412	31.407	30.4534	33.2008	26.5465	(E12 Btu/day)

[a] Definitions:
E3 is 1,000
E6 is 1,000,000
bbl is a barrel or 42 gallons
MW is one million watts
Scf is a cubic foot at standard temperature and pressure
Btu is British thermal unit

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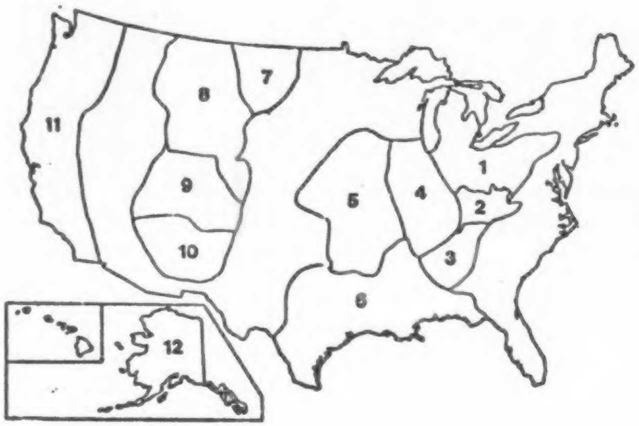
COAL SUPPLY REGIONS


11
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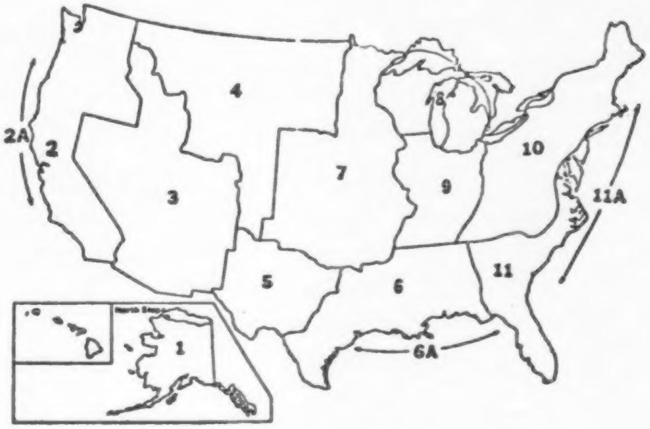
PETROLEUM SUPPLY REGIONS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10
11A
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11
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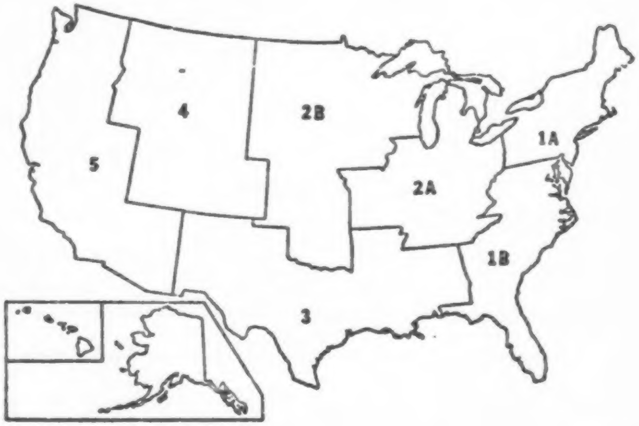
6A

PETROLEUM REFINERY (PAD) REGIONS


4
2B
5
2A
1A
1B
3

ELECTRIC UTILITY REGIONS

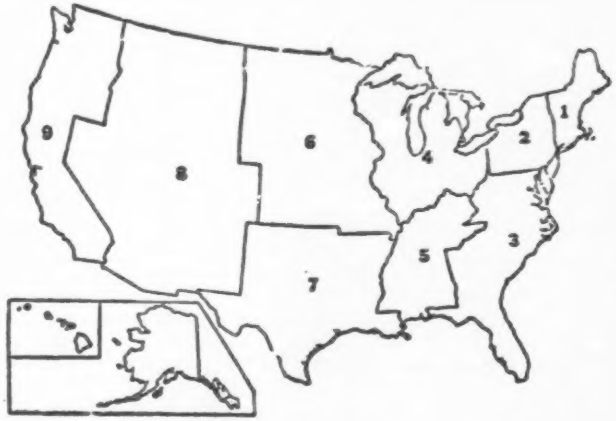


FIGURE 7-1

KEY TO SUPPLY, REFINERY, AND UTILITY REGIONS

TABLE 7-2

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

	REFERENCE 1985 VS 1972	1985 BUSINESS AS USUAL SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ACCELERATED SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ELECTRIFICATION VS 1985 REFERENCE	1985 REGIONAL LIMITATION VS 1985 REFERENCE	1985 ENVIRONMENTAL ADVISORY COMMITTEE SCENARIO VS 1985 REFERENCE
ALL COAL PRODUCTION	NATIONAL: 75% increase to 2,847,476 tons per day.	NATIONAL: 6% less at 2,661,244 tons per day	NATIONAL: 2% less at 2,776,473 tons per day	NATIONAL: 21% greater at 3,443,829 tons per day	NATIONAL: 2% less at 2,795,400 tons per day	NATIONAL: 17% less at 2,354,100 tons per day
UNDERGROUND COAL PRODUCTION	NATIONAL: 20% increase to 1,053,159 tons per day Major Regional Aspects 1) Coal Supply Region 2 - 58% increase to 452,202 tons per day	NATIONAL: 2% less at 1,031,236 tons per day Major Regional Aspects 1) Coal Supply Region 3 - 6% less at 298,260 tons per day	NATIONAL: 1% less at 1,043,297 tons per day No Major Regional Differences	NATIONAL: 2% greater at 1,077,542 tons per day Major Regional Aspects 1) Coal Supply Region 8 - Developed from no production to 2,740 tons per day	Identical to 1985 Reference Case	NATIONAL: 2% less at 1,032,700 tons per day Major Regional Aspects 1) Coal Supply Region 9 - 80% less at 3,000 tons per day
SURFACE COAL PRODUCTION	NATIONAL: 138% increase to 1,794,317 tons per day Major Regional Aspects 1) Coal Supply Region 8 - 1,774% increase to 744,560 tons per day 2) Coal Supply Region 2 - 204% increase to 322,653 tons per day 3) Coal Supply Region 7 - 196% increase to 85,705 tons per day 4) Coal Supply Region 6 - 409% increase to 58,460 tons per day	NATIONAL: 9% less at 1,630,008 tons per day Major Regional Aspects 1) Coal Supply Region 8 - 14% less at 646,358 tons per day	NATIONAL: 3% less at 1,733,176 tons per day Major Regional Aspects 1) Coal Supply Region 8 - 10% less at 666,892 tons per day	NATIONAL: 32% greater at 2,366,287 tons per day Major Regional Aspects 1) Coal Supply Region 4 - 34% greater at 366,205 tons per day 2) Coal Supply Region 8 - 47% greater at 1,095,197 tons per day	NATIONAL: 3% less at 1,741,800 tons per day Major Regional Aspects 1) Coal Supply Region 4 - 42% greater at 399,600 tons per day 2) Coal Supply Region 1 - 26% greater at 227,600 tons per day 3) Coal Supply Region 8 - 29% less at 529,500 tons per day	NATIONAL: 26% less at 1,321,400 tons per day Major Regional Aspects 1) Coal Supply Region 4 - 36% greater at 371,900 tons per day 2) Coal Supply Region 7 - 81% less at 15,560 tons per day 3) Coal Supply Region 8 - 52% less at 358,300 tons per day
OIL PRODUCTION	NATIONAL: 29% increase to 11,981,400 bbl per day Major Regional Aspects 1) North Slope production developed to 2,045,300 bbl per day 2) Petroleum Supply Region 11a - developed from a virgin area to 139,400 bbl per day 3) Petroleum Supply Region 2a - 902% increase to 649,980 bbl per day 4) Petroleum Supply Region 2 - 47% increase to 1,505,540 bbl per day 5) Petroleum Supply Region 6a - 28% increase to 1,418,700 bbl per day 6) Petroleum Supply Region 7 - 46% increase to 485,100 bbl per day	Identical to 1985 Reference Case	NATIONAL: 17% greater to 13,997,120 bbl per day Major Regional Aspects 1) Petroleum Supply Region 1 - 80% greater at 528,200 bbl per day 2) Petroleum Supply Region 6a - 36% greater at 1,930,500 bbl per day 3) North Slope - 24% greater at 2,539,000 bbl per day	Identical to 1985 Reference Case	Identical to 1985 Reference Case	NATIONAL: 6% less at 11,290,840 bbl per day Major Regional Aspects 1) Petroleum Supply Region 2A - 48% less at 331,000 bbl per day 2) Petroleum Supply Region 6A - 21% less at 1,123,900 bbl per day 3) Petroleum Supply Region 11A - 34% less at 90,600 bbl per day (These are offshore areas)
OIL IMPORTS	Import Total - 24% increase to 5,862,400 bbl per day Imported Crude - 110% increase to 4,666,600 bbl per day Imported Refined - 33% decrease to 1,165,630 bbl per day	Import Total - 33% less at 3,955,500 bbl per day Imported Crude - 51% less at 2,294,100 bbl per day Imported Refined - 38% greater at 1,651,300 bbl per day	Import Total - 70% less at 1,737,700 bbl per day Imported Crude - 100% drop; No crude imported Imported Refined - 45% greater at 1,737,700 bbl per day	Import Total - 16% less at 4,918,700 bbl per day Imported Crude - 33% less at 3,127,930 bbl per day Imported Refined - 58% greater at 1,790,800 bbl per day	Import Total - 1% less at 5,786,000 bbl per day Imported Crude - 2% less at 4,580,400 bbl per day Imported Refined - No difference	Import Total - 37% less at 3,700,750 bbl per day Imported Crude - 57% less at 1,997,600 bbl per day Imported Refined - 46% greater at 1,703,100 bbl per day

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TABLE 7-2 (CONT)

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

	REFERENCE 1985 VS 1972	1985 BUSINESS AS USUAL SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ACCELERATED SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ELECTRIFICATION VS 1985 REFERENCE	1985 REGIONAL LIMITATION VS 1985 REFERENCE	1985 ENVIRONMENTAL ADVISORY COMMITTEE SCENARIO VS 1985 REFERENCE
NATURAL GAS PRODUCTION	NATIONAL: 15% DECREASE TO 61,005.51 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) NORTH SLOPE PRODUCTION DEVELOPED TO 2,227.62 MILLION SCF PER DAY 2) PETROLEUM SUPPLY REGION 11A DEVELOPED FROM A VIRGIN AREA TO 110.77 MILLION SCF PER DAY 3) PETROLEUM SUPPLY REGION 6A - 36% INCREASE TO 14,459.37 MILLION SCF PER DAY 4) PETROLEUM SUPPLY REGION 2A - 929% INCREASE TO 566.05 MILLION SCF PER DAY 5) PETROLEUM SUPPLY REGION 1 - 122% INCREASE TO 897.06 MILLION SCF PER DAY 6) PETROLEUM SUPPLY REGION 6 - 44% DECREASE TO 19,935.66 MILLION SCF PER DAY 7) PETROLEUM SUPPLY REGION 3 - 61% DECREASE TO 1,689.73 MILLION SCF PER DAY 8) PETROLEUM SUPPLY REGION 2 - 49% DECREASE TO 669.73 MILLION SCF PER DAY	NATIONAL: 7% LESS AT 56,931.08 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 1 - 89% LESS AT 102.56 MILLION SCF PER DAY	NATIONAL: 9% GREATER AT 66,813.38 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 1 - 81% LESS AT 168.66 MILLION SCF PER DAY 2) PETROLEUM SUPPLY REGION 3 - 87% GREATER AT 3,162.21 MILLION SCF PER DAY 3) PETROLEUM SUPPLY REGION 6A - 42% GREATER AT 20,523.77 MILLION SCF PER DAY 4) NORTH SLOPE - 25% GREATER AT 2,813.37 MILLION SCF PER DAY	NATIONAL: 4% LESS AT 58,573.05 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 1 - 89% LESS AT 102.56 MILLION SCF PER DAY	NATIONAL: LESS THAN 1% DIFFERENCE AT 61,230 MILLION SCF PER DAY	NATIONAL: 10% LESS AT 55,209.5 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) PETROLEUM SUPPLY REGION 1 - 89% LESS AT 102.6 MILLION SCF PER DAY 2) PETROLEUM SUPPLY REGION 2A - 60% LESS AT 226.9 MILLION SCF PER DAY 3) PETROLEUM SUPPLY REGION 6A - 16% LESS AT 12,082.6 MILLION SCF PER DAY 4) PETROLEUM SUPPLY REGION 11A - 35% LESS AT 72.4 MILLION SCF PER DAY (THESE ARE OFFSHORE AREAS)
NATURAL GAS IMPORTS	TOTAL IMPORTS: IMPORTS CHANGE FROM ZERO LEVEL TO 3,458.7 MILLION SCF	IDENTICAL TO 1985 REFERENCE CASE	IDENTICAL TO 1985 REFERENCE CASE	IDENTICAL TO 1985 REFERENCE CASE	IDENTICAL TO 1985 REFERENCE CASE	IDENTICAL TO 1985 REFERENCE CASE
SYNTHETICS-HI BTU	NATIONAL: DEVELOPED TO 449.6 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) THE DEVELOPMENT IS SPLIT EVENLY BETWEEN COAL SUPPLY REGIONS 8 AND 4	IDENTICAL TO 1985 REFERENCE CASE	NATIONAL: 200% GREATER AT 1,348.8 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGIONS 1, 2, 4, AND 7 - DEVELOPED TO 224.8 MILLION SCF PER DAY	NATIONAL: 200% GREATER AT 1,348.8 MILLION SCF PER DAY MAJOR REGIONAL ASPECTS 1) COAL SUPPLY REGIONS 1, 2, 4, AND 7 - DEVELOPED TO 224.8 MILLION SCF PER DAY	IDENTICAL TO 1985 REFERENCE CASE	THERE IS NO SYNTHETICS PRODUCTION.
OIL SHALE PRODUCTION	NATIONAL: DEVELOPED TO 300,000 BBL PER DAY ALL PRODUCTION IS SURFACE AND IS LOCATED IN THE ROCKY MOUNTAIN REGION	IDENTICAL TO 1985 REFERENCE CASE	IDENTICAL TO REFERENCE CASE	IDENTICAL TO REFERENCE CASE	IDENTICAL TO 1985 REFERENCE CASE	THERE IS NO OIL SHALE PRODUCTION
REFINERY PRODUCTION	NATIONAL: 28% INCREASE TO 17,742,200 BBL PER DAY MAJOR REGIONAL FEATURES 1) PAD 2A - 85% INCREASE TO 4,010,400 BBL PER DAY 2) PAD 2B - 33% DECREASE TO 1,032,600 BBL PER DAY 3) THERE ARE SUBSTANTIAL INCREASES IN ALL OTHER PAD'S	NATIONAL: 13% LESS AT 15,398,000 BBL PER DAY MAJOR REGIONAL ASPECTS 1) PAD 2A - 39% LESS AT 2,442,400 BBL PER DAY 2) PAD 3 - 13% LESS AT 5,424,000 BBL PER DAY	NATIONAL: 16% LESS AT 14,901,900 BBL PER DAY MAJOR REGIONAL ASPECTS 1) PAD 2A - 47% LESS AT 2,100,310 BBL PER DAY 2) PAD 1A - 15% LESS AT 1,522,830 BBL PER DAY 3) PAD 3 - 11% LESS AT 5,537,209 BBL PER DAY	NATIONAL: 8% LESS AT 16,315,900 BBL PER DAY MAJOR REGIONAL ASPECTS 1) PAD 2A - 16% LESS AT 3,360,300 BBL PER DAY 2) PAD 3 - 13% LESS AT 5,424,000 BBL PER DAY	NATIONAL: 4% GREATER AT 18,436,000 BBL PER DAY MAJOR REGIONAL ASPECTS 1) PAD 1A - 15% GREATER AT 2,054,000 BBL PER DAY	NATIONAL - 19% LESS AT 14,285,000 BBL PER DAY MAJOR REGIONAL ASPECTS 1) PAD 2A - 63% LESS AT 1,501,300 BBL PER DAY 2) PAD 3 - 10% LESS AT 5,594,000 BBL PER DAY 3) PAD 4 - 35% LESS AT 306,000 BBL PER DAY

TABLE 7-2 (CONT)

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

	REFERENCE 1985 VS 1972	1985 BUSINESS AS USUAL SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ACCELERATED SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ELECTRIFICATION VS 1985 REFERENCE	1985 REGIONAL LIMITATION VS 1985 REFERENCE	1985 ENVIRONMENTAL ADVISORY COMMITTEE SCENARIO VS 1985 REFERENCE
COAL-FIRED POWER PLANTS	NATIONAL: 101% increase to 1,810,629 tons per day Major Regional Aspects 1) There are large increases in all Demand Regions 2) Demand Region 9 is developed to 23,120 tons per day	NATIONAL: 2% less at 1,658,977 tons per day Major Regional Aspects 1) Demand Region 9 - 76% less at 5,554 tons per day	NATIONAL: 10% less at 1,654,152 tons per day	NATIONAL: 13% greater at 2,048,816 tons per day Major Regional Aspects 1) Demand Region 1 - 93% greater at 87,296 tons per day 2) Demand Region 7 - 14% greater at 296,199 tons per day	NATIONAL: 2% less at 1,836,900 tons per day Major Regional Aspects 1) Demand Region 9 - 76% less at 5,554 tons per day	NATIONAL: 19% less at 1,577,800 tons per day Major Regional Aspects 1) Demand Region 2 - 72% less at 233,500 tons per day 2) Demand Region 6 - 29% less at 256,400 tons per day 3) Demand Region 9 - 76% less at 5,554 tons per day
OIL-FIRED POWER PLANTS	NATIONAL: 34% decrease to 995,996 bbl per day Major Regional Aspects 1) Demand Region 9 - 225% increase to 292,315 bbl per day 2) Demand Region 1 - 55% decrease to 395,037 bbl per day 3) Demand Region 3 - 43% decrease to 244,872 bbl per day	NATIONAL: 28% less at 718,940 bbl per day Major Regional Aspects 1) Demand Region 9 - 96% less at 11,277 bbl per day	NATIONAL: 56% less at 442,886 bbl per day Major Regional Aspects 1) Demand Region 9 - 96% less at 11,262 bbl per day	NATIONAL: 35% less at 649,467 bbl per day Major Regional Aspects 1) Demand Region 9 - 96% less at 11,277 bbl per day	NATIONAL: 2% less at 984,785 bbl per day Major Regional Aspects 1) Demand Region 9 - 5% less at 277,883 bbl per day	NATIONAL: 28% less at 718,960 bbl per day Major Regional Aspects 1) Demand Region 9 - 96% less at 11,277 bbl per day
NATURAL GAS-FIRED POWER PLANTS	NATIONAL: 19% decrease to 8,093.04 million SCF per day Major Regional Aspects 1) Demand Region 2 - developed to 637.75 million SCF per day 2) Demand Region 4 - 116% increase to 417.17 million SCF per day 3) Demand Region 9 - 99% decrease to 22.5 million SCF per day 4) Demand Region 6 - 68% decrease to 287.07 million SCF per day	NATIONAL: 22% greater at 9,850.45 million SCF per day Major Regional Aspects 1) Demand Region 9 - 7607% greater at 1,734.87 million SCF per day	NATIONAL: 46% greater at 11,827.990 million SCF per day Major Regional Aspects 1) Demand Region 7 - 26% greater at 6,536.121 million SCF per day 2) Demand Region 9 - 9959% greater at 2,248.865 million SCF per day	NATIONAL: 6% greater at 8,578.599 million SCF per day Major Regional Aspects 1) Demand Region 9 - 7609% greater at 1,734.87 million SCF per day 2) Demand Region 7 - 24% less at 3,951.522 million SCF per day	NATIONAL: 1% greater at 8,220.3 million SCF per day Major Regional Aspects 1) Demand Region 9 - 412% greater at 115.3 million SCF per day	NATIONAL: 28% greater at 10,379.7 million SCF per day Major Regional Aspects 1) Demand Region 9 - [illegible] greater at 2,041 million SCF per day
GAS TURBINE POWER PLANTS	NATIONAL: 457% increase to 188,685 bbl per day Major Regional Aspects 1) Demand Region 9 - 4,454% increase to 67,323 bbl per day 2) Demand Region 4 - 906% increase to 43,631 bbl per day 3) Demand Region 5 - 2,308% increase to 23,379 bbl per day 4) Demand Region 7 - developed to 32,601 bbl per day	NATIONAL: 14% greater at 215,465 bbl per day Major Regional Aspects 1) Demand Region 9 - 55% Greater at 104,172 bbl per day	NATIONAL: 89% less at 20,473 bbl per day Major Regional Aspects 1) No generation in Demand Regions 1, 2, 3, 6, 8, and 9 2) Demand Region 4 - 91% less at 3,895 bbl per day 3) Demand Region 5 - 83% less at 3,953 bbl per day 4) Demand Region 7 - 61% less at 12,817 bbl per day	NATIONAL: 5% less at 179,280 bbl per day Major Regional Aspects 1) Demand Region 9 - 59% less at 27,705 bbl per day	NATIONAL: 38% greater at 260,084 bbl per day Major Regional Aspects 1) Demand Region 9 - 105% greater at 138,325 bbl per day	NATIONAL: 26% greater at 238,235 bbl per day Major Regional Aspects 1) Demand Region 9 - 151% greater at 255,284 bbl per day
HYDRO-ELECTRIC POWER PLANTS	NATIONAL: 142% increase to 186,363 Mwatts	Identical to 1985 Reference Case	Identical to 1985 Reference Case	Identical to 1985 Reference Case	Identical to 1985 Reference Case	Identical to 1985 Reference Case
NUCLEAR POWER PLANTS	NATIONAL: 11,925% increase to .403 tons U-235 per day Major Regional Aspects 1) There are large increases in all Demand Regions	NATIONAL: 3% less at .460 tons U-235 per day Major Regional Aspects 1) Demand Region 8 - 17% less at .011 tons U-235 per day 2) Demand Region 9 - 31% less at .035 tons U-235 per day	NATIONAL: Same level as Reference Case Major Regional Aspects 1) Lower levels in Demand Regions 5, 7, 8, and 9 offset by higher levels in Regions 1, 2, 3, and 4	NATIONAL: 15% greater at .505 tons U-235 per day Major Regional Aspects 1) Demand Regions 1, 2, 3, 4, and 5 slightly greater 2) Demand Region 9 - 30% less at .035 tons U-235 per day	Identical to 1985 Reference Case	NATIONAL: 36% less at .258 tons U-235 per day Major Regional Aspects 1) Demand Region 5 - 73% less at .017 tons U-235 per day 2) Demand Region 7 - 75% less at .035 tons U-235 per day

TABLE 7-2 (CONT)

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

	REFERENCE 1985 VS 1972	1985 BUSINESS AS USUAL SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ACCELERATED SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ELECTRIFICATION VS 1985 REFERENCE	1985 REGIONAL LIMITATION VS 1985 REFERENCE	1985 ENVIRONMENTAL ADVISORY COMMITTEE SCENARIO VS 1985 REFERENCE
TRANSPORTATION GASOLINE	NATIONAL: 6% INCREASE TO 7,538,545 BBL PER DAY MAJOR REGIONAL ASPECTS 1) DEMAND REGION 3 - 64% INCREASE TO 1,506,437 BBL PER DAY 2) DEMAND REGION 7 - 23% INCREASE TO 952,236 BBL PER DAY 3) DEMAND REGION 1 - 28% DECREASE TO 333,243 BBL PER DAY	NATIONAL: 15% LESS AT 6,414,070 BBL PER DAY	NATIONAL: 15% LESS AT 6,429,350 BBL PER DAY	NATIONAL: 0.2% LESS AT 7,521,480 BBL PER DAY	IDENTICAL TO 1985 REFERENCE CASE	NATIONAL: 23% LESS AT 5,777,390 BBL PER DAY
TRANSPORTATION JET FUEL	NATIONAL: 83% INCREASE TO 1,980,020 BBL PER DAY MAJOR REGIONAL ASPECTS 1) THERE ARE LARGE INCREASES IN DEMAND REGIONS 1, 2, 3, 4, 6, 8, AND 9	NATIONAL: 6% LESS AT 1,854,490 BBL PER DAY	NATIONAL: 6% LESS AT 1,854,130 BBL PER DAY	NATIONAL: 0.2% LESS AT 1,976,880 BBL PER DAY	IDENTICAL TO 1985 REFERENCE CASE	NATIONAL: 10% LESS AT 1,783,340 BBL PER DAY
TRANSPORTATION DISTILLATE	NATIONAL: 40% INCREASE TO 1,352,410 BBL PER DAY MAJOR REGIONAL ASPECTS 1) DEMAND REGION 7 - 77% INCREASE TO 268,620 BBL PER DAY 2) DEMAND REGION 9 - 77% INCREASE TO 221,550 BBL PER DAY	IDENTICAL TO 1985 REFERENCE CASE	NATIONAL: 1% GREATER AT 1,361,570 BBL PER DAY	NATIONAL: 0.2% GREATER AT 1,355,980 BBL PER DAY	IDENTICAL TO 1985 REFERENCE CASE	NATIONAL: 8% LESS AT 1,243,820 BBL PER DAY
TRANSPORTATION RESIDUAL	NATIONAL: 37% INCREASE TO 276,580 BBL PER DAY MAJOR REGIONAL ASPECTS 1) DEMAND REGION 2 - 472% INCREASE TO 118,620 BBL PER DAY 2) DEMAND REGION 9 - 74% DECREASE TO 15,140 BBL PER DAY 3) DEMAND REGION 7 - 63% DECREASE TO 15,660 BBL PER DAY	IDENTICAL TO 1985 REFERENCE CASE	IDENTICAL TO 1985 REFERENCE CASE	NATIONAL: 0.1% GREATER AT 277,580 BBL PER DAY	IDENTICAL TO 1985 REFERENCE CASE	NATIONAL: 2% GREATER AT 281,840 BBL PER DAY
INDUSTRIAL COAL	NATIONAL: 134% INCREASE TO 393,090 TONS PER DAY MAJOR REGIONAL ASPECTS 1) THERE ARE LARGE INCREASES IN ALL DEMAND REGIONS	NATIONAL: 2% LESS AT 383,000 TONS PER DAY MAJOR REGIONAL ASPECTS 1) DEMAND REGION 4 - 15% LESS AT 130,470 TONS PER DAY	NATIONAL: 8% LESS AT 363,720 TONS PER DAY MAJOR REGIONAL ASPECTS 1) DEMAND REGION 4 - 21% LESS AT 120,770 TONS PER DAY	NATIONAL: 37% GREATER AT 538,630 TONS PER DAY MAJOR REGIONAL ASPECTS 1) DEMAND REGION 7 - 6,977% GREATER AT 74,310 TONS PER DAY	NATIONAL: 3% GREATER AT 405,300 TONS PER DAY	NATIONAL: 16% LESS AT 330,510 TONS PER DAY MAJOR REGIONAL ASPECTS 1) DEMAND REGION 4 - 33% LESS AT 101,390 TONS PER DAY

TABLE 7-2 (CONT)

COMPARISON OF ENERGY PRODUCTION ACTIVITIES

	REFERENCE 1985 VS 1972	1985 BUSINESS AS USUAL SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ACCELERATED SUPPLY WITH CONSERVATION VS 1985 REFERENCE	1985 ELECTRIFICATION VS 1985 REFERENCE	1985 REGIONAL LIMITATION VS 1985 REFERENCE	1985 ENVIRONMENTAL ADVISORY COMMITTEE SCENARIO VS 1985 REFERENCE
INDUSTRIAL NATURAL GAS	NATIONAL: 95% increase to 30,671.87 million SCF per day Major Regional Aspects 1) There are large increases in all Demand Regions	NATIONAL: 5% less at 32,671.08 million SCF per day Major Regional Aspects 1) Demand Region 3 - 15% less at 2,926.4 million SCF per day	NATIONAL: 6% greater at 36,432 million SCF per day Major Regional Aspects 1) Demand Region 4 - 9% greater at 6,236,047 million SCF per day 2) Demand Region 7 - 6% greater at 17,091.484 million SCF per day	NATIONAL: 9% less at 31,305.594 million SCF per day	Identical to 1985 Reference Case	NATIONAL: 13% less at 30,309.3 million SCF per day Major Regional Aspects 1) Demand Region 3 - 28% less at 2,498.9 million SCF per day
INDUSTRIAL DISTILLATE	NATIONAL: 113% increase to 610,440 bbl per day Major Regional Aspects 1) There are large increases in all Demand Regions	NATIONAL: 5% less at 578,310 bbl per day	NATIONAL: 10% less at 547,420 bbl per day	NATIONAL: 0.6% less at 606,570 bbl per day	Identical to 1985 Reference Case	NATIONAL: 11% less at 540,540 bbl per day
INDUSTRIAL RESIDUAL	NATIONAL: 102% increase to 778,840 bbl per day Major Regional Aspects 1) There are large increases in all Demand Regions	NATIONAL: 9% less at 705,930 bbl per day	NATIONAL: 10% less at 695,590 bbl per day	NATIONAL 1% greater at 785,290 bbl per day	Identical to 1985 Reference Case	NATIONAL: 17% less at 648,540 bbl per day
RESIDENTIAL-COMMERCIAL NATURAL GAS	NATIONAL: 131% increase to 17,097.61 million SCF per day Major Regional Aspects 1) There are large increases in all Demand Regions	NATIONAL: 12% less at 14,977.22 million SCF per day	NATIONAL: Same level as Reference Case Major Regional Aspects 1) Lower levels in Demand Regions 1, 3, 6, and 9 offset by higher levels in Demand Regions 4, 5, 7, and 8	NATIONAL: 6.2% greater at 18,151.53 million SCF per day	Identical to 1985 Reference Case	NATIONAL: 21% less at 13,509.3 million SCF per day
RESIDENTIAL-COMMERCIAL DISTILLATE	NATIONAL: 34% increase to 2,006,649 bbl per day Major Regional Aspects 1) Demand Region 2 - 89% increase to 659,760 bbl per day 2) Demand Region 3 - 45% increase to 256,540 bbl per day 3) Demand Region 4 - 34% increase to 422,009 bbl per day	NATIONAL: 13% less at 1,739,089 bbl per day	NATIONAL: 15% less at 1,096,699 bbl per day Major Regional Aspects 1) Demand Region 2 - 14% less at 588,060 bbl per day	NATIONAL: 27% less at 1,472,394 bbl per day	Identical to 1985 Reference Case	NATIONAL: 23% less at 1,547,000 bbl per day
RESIDENTIAL-COMMERCIAL RESIDUAL	NATIONAL: 24% increase to 636,650 bbl per day Major Regional Aspects 1) Demand Region 2 - 113% increase to 289,140 bbl per day	NATIONAL: 1% greater at 643,779 bbl per day	NATIONAL: Identical to Reference Case	NATIONAL: 18% less at 520,170 bbl per day	Identical to 1985 Reference Case	NATIONAL: 8% less at 585,930 bbl per day

TABLE 7-3

COMPARISON OF NATIONAL POLLUTION LOADINGS OF REFERENCE CASE WITH OTHER SCENARIOS IN 1985

POLLUTANT [a]	REF	PERCENT GREATER THAN REF				
		BAU/C	AS/C	ELEC	REG/LIM	EAC
Total Dissolved Solids (100 tons/day)	57.5	-10	-10	-1	4	-12
Suspended Solids (tons/day)	308	-3	-1	7	0	-10
Organics (100 tons/day)	1.61	-3	13	3	1	-15
Thermal (billion Btu/day)	26400	-5	-4	7	2	-12
Particulates (tons/day)	11100	-7	-9	10	2	-17
Nitrogen Oxides (tons/day)	73900	-7	-7	5	2	-13
Sulfur Oxides (tons/day)	61200	-5	0	8	1	-12
Hydrocarbons (tons/day)	41100	-8	-3	-3	0	-16
Carbon Monoxide (tons/day)	131000	-14	-14	0	0	-22
Solids (100 tons/day)	1060	-4	-3	6	6	-50
Fixed Land (100 acres)	341000	0	0	0	0	0
Maximum Incremental Land (100 acres)	22600	-2	-1	4	3	-1

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[a] Acids, bases and aldehydes are not included.

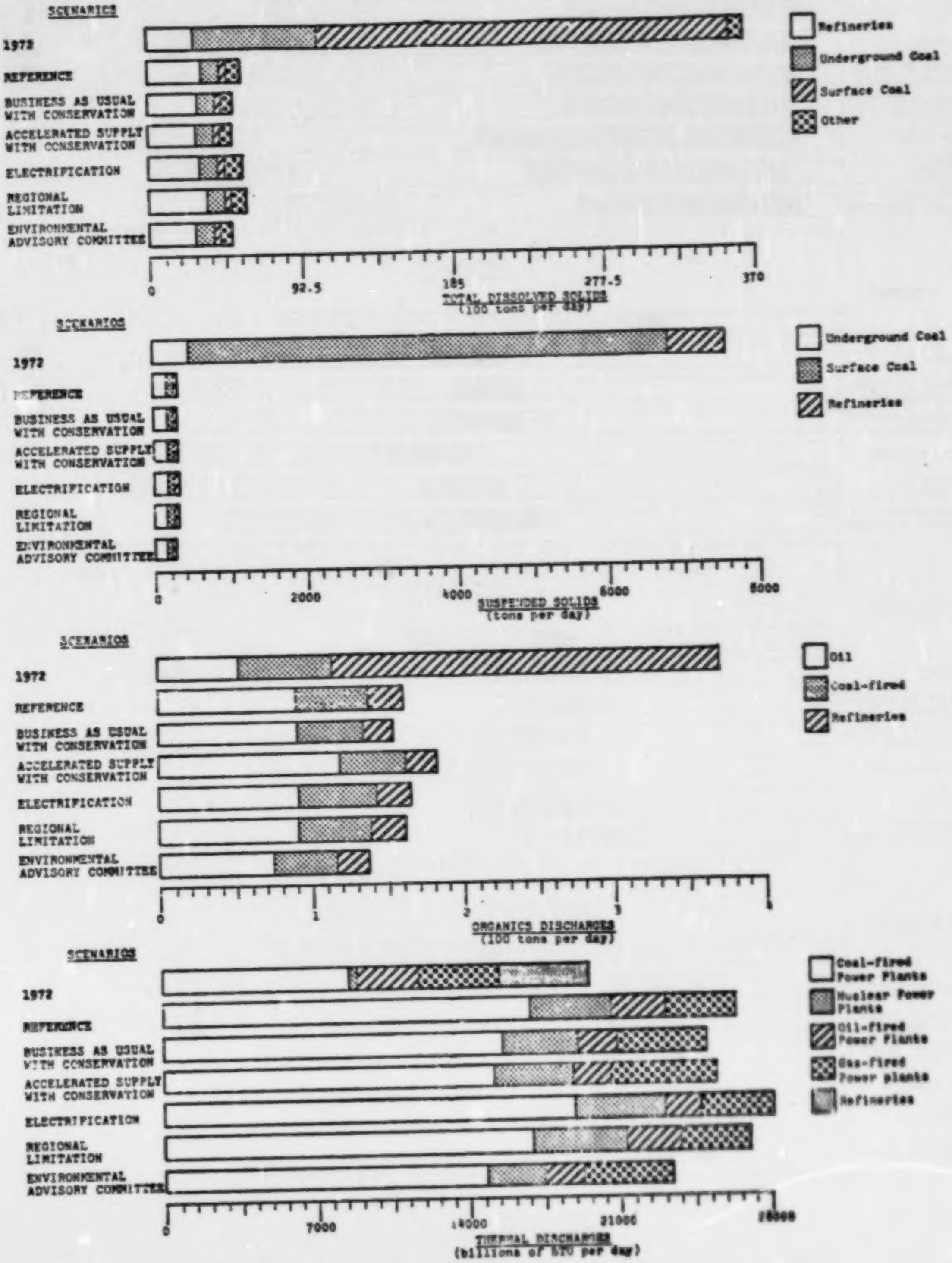
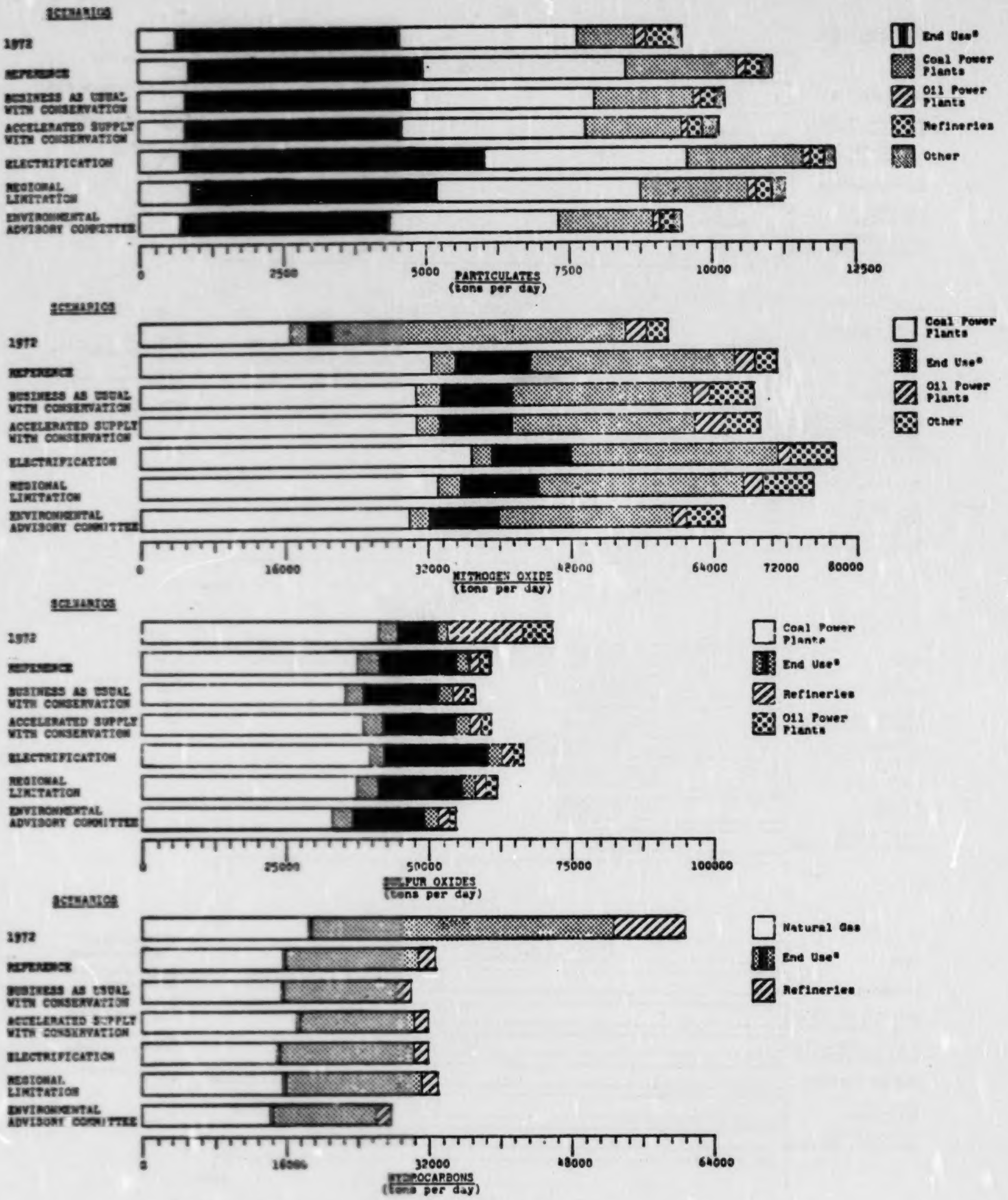


FIGURE 7-2

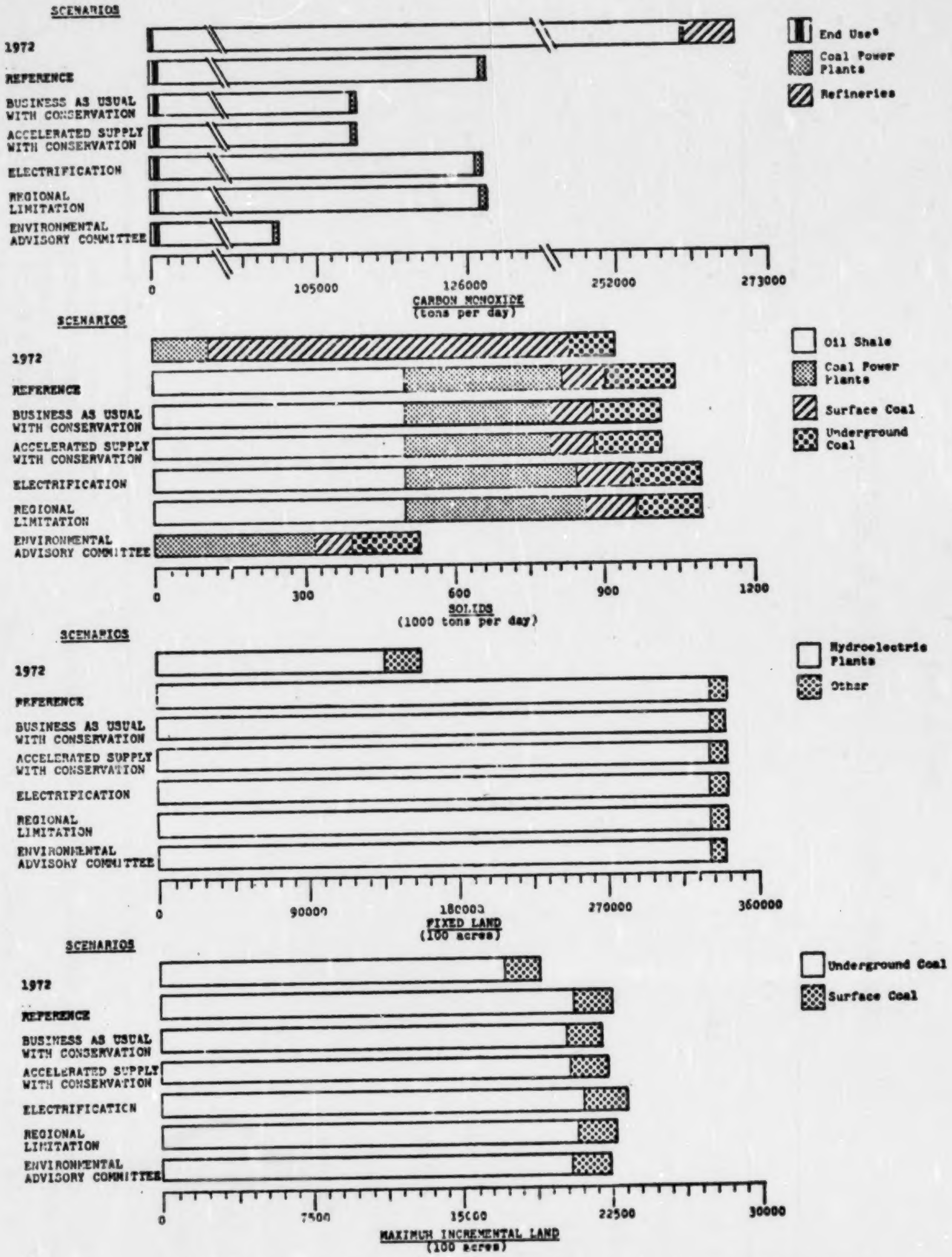
1972 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES



* 123 End Use is divided into 1) Household/Commercial, 2) Industrial and 3) Transportation.

FIGURE 7-2 (CONT.)

1972 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES



* 123 End Use is divided into 1) Household/Commercial, 2) Industrial and 3) Transportation.

FIGURE 7-2 (CONT.)

1972 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES

TABLE 7-4

RELATIVE RANKING[a] OF SCENARIOS BY RESIDUAL[b]

	REF	BAU/C	AS/C	ELEC	REG/LIM	EAC
Total Dissolved Solids	5	2	2	4	6	1
Suspended Solids	4	2	3	6	4	1
Organics	3	2	6	5	4	1
Thermal	4	2	3	6	5	1
Particulates	4	3	2	6	5	1
Nitrogen Oxides	4	2	2	6	5	1
Sulfur Oxides	4	2	3	6	5	1
Hydrocarbons	5	2	3	3	5	1
Carbon Monoxide	4	2	2	4	4	1
Solids	4	2	3	6	5	1
Fixed Land	1	1	1	1	1	1
Maximum Inremental Land	4	1	2	6	5	2

[a] In case of equal rankings, the lower number is assigned.

[b] Acids, bases and aldehydes are not included.

1 = lowest loadings
2 = second lowest loadings
3 = third lowest loadings
4 = third highest loadings
5 = second highest loadings
6 = highest loadings

The lower loadings in BAU/C than in REF are due simply to conservation policies in the demand sector. Conservation not only affects end-use but supply as well. The fact that more energy raw materials are supplied domestically in AS/C than in BAU/C accounts for the difference in loadings. AS/C has generally lower loadings than REF because the effects of greater domestic energy supply in AS/C are more than offset by the higher levels of conversion activities and end-use associated with REF. It may be unfair to compare ELEC to the other scenarios. One of the reasons for an electrification scenario is to reduce the end-use impacts and centralize the loadings at the power plants, where emissions are better controlled. The ELEC scenario supplied by FEA for analysis does not reflect conservation policies, and to compare it to scenarios that do masks the benefits of electrification. However, it is fair to note that ELEC relies heavily on coal to produce the large amounts of electricity required to supplant direct end-use of other fuels. The coal is domestically supplied and, apparently as a result of expanded coal development for power generation, excess is extracted to provide far more coal for industrial uses than in any other scenario. REG/LIM is very similar to REF. The major difference occurs in Demand Region 9 where REG/LIM has substantially more fossil-fueled electricity generation than REF, accounting for most of the differences between those scenarios nationally.

EAC is a scenario characterized by a very low level of demand. End-use consumption in this scenario is up to 20 percent less than in the conservation scenarios (BAU/C, AS/C). This reduction is caused mainly by a Btu tax and a 25 mile per gallon minimum automobile efficiency standard. The lower demand imposes lower supply requirements and, therefore, lower loadings from the supply of energy as well.

Figure 7-2 demonstrates that energy consumption for end-use is a major cause of pollution loadings. It is also clear from Figure 7-2, and Tables 7-3 and 7-4 that conservation policies contribute significantly to the reduction of loadings due to consumption and supply of energy. Reduced demand implies lower supply levels to meet demand and, therefore, lower residual loadings at both ends. It is on this policy -- conservation -- that energy and environmental policy makers agree unconditionally. A major result of the analysis of these scenarios is that conservation can be an effective policy to improve the energy balance and minimize environmental impacts.

Table 7-5 gives a national and regional breakdown of loadings for each scenario. The major points are:

- EAC has significantly lower loadings in almost every Demand Region for almost all pollutants than any other scenario.
- Particulates, NO_x, hydrocarbons, carbon monoxide and aldehydes loadings due to gasoline fueled transportation are higher in all Demand Regions for REF, ELEC and REG/LIM, where conservation measures are less stringent.
- Due to higher levels in all phases of the coal fuel cycle in ELEC, this scenario experiences considerably higher loadings than the other scenarios in most regions, for most pollutants.
- Thermal, NO_x, SO_x and solids loadings due to coal-fired power generation are higher in Demand Regions 1,2 and 7 for ELEC and in Demand Region 5 for AS/C and REG/LIM.
- Particulates, NO_x and SO_x loadings due to fossil-fueled power generation are higher in Demand Region 9 for REG/LIM.
- Particulates, NO_x and SO_x loadings due to industrial coal use are higher in Demand Regions 4,6,7,8 and 9 for ELEC.
- Hydrocarbon loadings are greater in Demand Regions 7,8 and 10 for AS/C and in Demand Region 10 for REF and REG/LIM due to natural gas production.
- SO_x loadings are greater in Demand Region 9 for REF and REG/LIM due to oil-fired power generation.
- Organic loadings are greater in Demand Regions 7 and 10 for AS/C due to greater oil production.

7.3.2 Water-Use Comparisons

Comparison of energy-related water consumption to water availability for energy use shows four major conclusions regarding energy-related water demand in 1985 (see Table 7-6):

TABLE 7-5

POLLUTION LOADINGS

ACIDS (TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
2	212.1	0.0	0.0	0.0	0.0	0.0	0.0
3	377.6	0.0	0.0	0.0	0.0	0.0	0.0
4	271.0	0.0	0.0	0.0	0.0	0.0	0.0
5	171.1	0.0	0.0	0.0	0.0	0.0	0.0
6	44.2	0.0	0.0	0.0	0.0	0.0	0.0
7	5.0	0.0	0.0	0.0	0.0	0.0	0.0
8	10.6	0.0	0.0	0.0	0.0	0.0	0.0
9	2.1	0.0	0.0	0.0	0.0	0.0	0.0
10	0.5	0.0	0.0	0.0	0.0	0.0	0.0
11	1096.7	0.0	0.0	0.0	0.0	0.0	0.0

BASES (TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	4.833	6.606	6.294	6.606	6.805	7.948	7.479
3	6.832	17.533	17.114	17.404	18.214	17.447	16.436
4	3.770	8.530	8.321	9.035	10.158	9.473	8.729
5	5.099	7.020	6.900	7.000	7.334	8.170	7.966
6	0.110	0.208	0.208	0.251	0.274	0.353	0.117
7	0.079	0.125	0.125	0.131	0.135	0.182	0.074
8	0.073	0.414	0.414	0.414	0.414	0.743	0.208
9	0.031	0.104	0.025	0.067	0.180	0.025	0.075
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	22.843	40.940	39.482	40.917	43.222	44.540	41.275

TOTAL DISSOLVED SOLIDS (100 TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	0.25	0.28	0.25	0.23	0.47	0.29	0.20
2	15.20	7.21	6.98	6.52	7.53	8.17	7.37
3	23.89	9.55	9.33	9.59	10.37	9.99	8.63
4	161.62	11.03	9.19	9.03	11.51	12.29	7.77
5	95.98	4.80	4.45	4.36	4.69	5.22	4.76
6	10.12	2.28	2.10	2.05	2.26	2.37	1.83
7	22.22	11.96	10.36	10.71	11.13	11.77	10.66
8	27.16	2.07	2.03	2.06	2.02	2.39	1.55
9	5.17	6.93	6.89	6.90	6.95	7.34	7.2[illegible]
10	0.14	0.17	0.17	0.17	0.17	0.18	0.16
11	369.75	57.49	51.93	51.82	57.09	60.02	50.15

SUSPENDED SOLIDS (TONS/DAY)

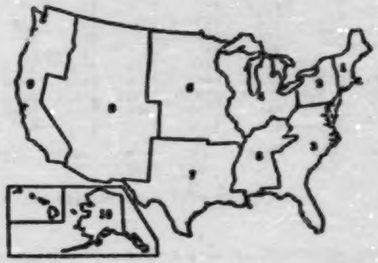
DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
2	1 60.7	32.0	30.6	31.0	34.2	37.6	33.9
3	1740.2	137.0	135.7	136.3	145.8	123.2	113.2
4	1510.4	44.0	40.5	44.3	54.8	51.2	41.0
5	2695.4	57.4	57.0	57.0	60.0	57.7	54.2
6	55.2	1.7	1.6	1.9	2.1	2.6	1.0
7	231.0	20.6	19.9	20.1	20.0	20.7	19.0
8	82.3	3.4	3.4	3.6	3.4	4.2	2.4
9	100.6	9.6	9.2	9.4	9.6	9.4	9.3
10	2.7	0.2	0.2	0.2	0.2	0.2	0.2
11	7300.0	307.3	298.1	304.3	330.1	306.0	275.9

ORGANICS (100 TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	0.083	0.024	0.022	0.027	0.034	0.024	0.013
2	0.303	0.106	0.099	0.094	0.120	0.107	0.089
3	0.268	0.170	0.162	0.186	0.171	0.170	0.143
4	0.566	0.153	0.140	0.135	0.154	0.154	0.129
5	0.285	0.062	0.056	0.064	0.057	0.062	0.065
6	0.335	0.064	0.060	0.057	0.065	0.064	0.050
7	1.464	0.583	0.575	0.705	0.612	0.581	0.505
8	0.179	0.065	0.064	0.063	0.064	0.065	0.063
9	0.491	0.246	0.246	0.280	0.246	0.248	0.170
10	0.017	0.134	0.134	0.209	0.134	0.144	0.142
11	3.781	1.687	1.559	1.820	1.655	1.620	1.371

THERMAL (E9 BTU/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	1034	1063	997	767	1473	1099	897
2	1552	4250	3980	3951	4724	4355	3653
3	3999	5199	4964	4781	5403	5337	4559
4	3330	5646	5414	5416	5809	5776	4962
5	2000	2451	2271	2496	2352	2552	2265
6	1259	2224	2116	2044	2241	2243	1754
7	3671	3257	3094	3414	3911	3296	2947
8	984	1167	1137	1179	1320	1376	1247
9	1732	895	853	991	854	978	965
10	17	0	0	0	0	0	0
11	19590	26357	25038	25442	28179	27015	23251



#DEMAND REGION INDEX

1) North East
2) Mid-Atlantic
3) South-Atlantic
4) East North Central
5) East South Central
6) West North Central
7) West South Central
8) Mountain
9) Pacific
10) Alaska
11) National

TABLE 7-5 (CONT.)

POLLUTION LOADINGS

PARTICULATES (TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	372	457	452	443	462	458	403
2	1425	1750	1600	1546	1761	1765	1453
3	1791	1880	1818	1765	1962	1918	1656
4	2604	2738	2415	2308	2889	2770	2076
5	909	1074	1019	1038	1088	1104	958
6	622	857	605	790	944	843	686
7	762	750	732	747	1382	764	607
8	277	467	458	454	523	465	316
9	661	1049	926	931	1139	1206	870
10	12	29	28	28	29	36	26
11	9440	11064	10257	10074	12182	11355	9136

HYDROCARBONS (TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	2189	905	786	793	901	905	705
2	6203	2804	2465	2420	2794	2837	2277
3	7380	3399	2992	3192	3379	3423	2663
4	9511	4064	3473	3430	3984	4083	3065
5	3690	1483	1282	1286	1467	1484	1177
6	5165	2785	2549	2499	2755	2786	2391
7	27397	17495	16783	16357	16951	17543	15702
8	4982	2799	2625	3216	2725	2802	2480
9	7279	4241	3767	3803	4216	4361	3406
10	225	1085	825	1030	832	1008	703
11	74027	41064	37551	40040	40008	41316	34653

SOLIDS (1000 TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	0.5	14.0	12.0	8.3	23.4	14.5	6.8
2	160.7	74.3	67.7	67.9	83.5	87.0	71.4
3	236.7	155.2	150.3	160.3	147.1	161.4	147.4
4	224.0	133.7	124.6	115.1	145.3	144.2	121.7
5	207.2	96.7	93.0	105.3	94.2	105.3	120.3
6	9.5	48.2	46.7	47.3	50.2	58.7	35.9
7	2.1	12.9	10.8	10.0	25.7	15.2	9.7
8	6.7	519.6	510.0	519.2	524.1	517.0	16.6
9	1.0	1.6	1.0	1.3	1.7	1.6	1.6
10	0.2	0.0	0.0	0.0	0.0	0.0	0.0
11	928.5	1056.1	1024.2	1034.8	1115.1	1105.0	528.6

NO(X) (TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	2790	2600	2393	2249	3218	2595	2058
2	6531	10830	9968	9650	11582	10795	8945
3	12477	12876	12075	11725	13058	12921	11328
4	12323	16192	15040	14651	16406	16402	13006
5	6661	6469	5974	6579	6134	6545	6360
6	5087	6767	6369	6264	6934	6815	5411
7	7066	8845	8241	8590	11226	8867	7870
8	3492	4246	4117	4317	4217	4244	3953
9	5440	4875	4509	4698	4886	5846	4747
10	71	143	134	137	139	172	127
11	61940	73867	68824	68863	77803	75207	64608

CARBON MONOXIDE (TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	14545	6504	5577	5587	6497	6504	5018
2	35053	18707	16039	16068	18679	18704	14544
3	44277	19723	16878	16908	19689	19729	15247
4	51032	23571	20318	20447	23519	23597	18224
5	20218	9441	8073	8108	9424	9444	7358
6	23235	10433	8979	9002	10416	10434	8094
7	32410	13570	11738	11779	13619	13571	10570
8	13698	7035	6063	6085	7028	7032	5540
9	38192	21803	18618	18690	21764	22313	16854
10	351	365	317	318	365	374	287
11	273817	131157	112636	112997	131003	131706	101749.

FIXED LAND (100 ACRES)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	2357	10345	10333	10323	10412	10337	10314
2	11115	50108	50065	49999	50180	50203	50056
3	5187	43503	43424	43451	43527	43556	43393
4	2428	10057	9755	9681	10008	10123	9551
5	10200	22218	22160	22210	22182	22262	22237
6	15921	15663	15631	15609	15665	15699	15572
7	15474	12898	12712	12887	12094	12939	12673
8	30503	20744	20726	20733	20761	20770	20631
9	64482	155053	154974	154990	154977	155124	155041
10	340	679	672	705	672	650	661
11	158012	341274	340456	340671	341262	341469	340684

SO(X) (TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	2791	2359	2307	2323	2772	2354	2139
2	8192	9743	9110	9439	10627	9809	8570
3	17931	11545	11225	11006	11823	11655	10403
4	17754	19331	18192	20033	19905	19457	16250
5	9904	5827	5544	6193	5663	5918	4936
6	4532	6046	6513	6074	6903	6662	5866
7	5700	2003	1895	1600	4954	1989	1795
8	1534	1790	1816	1862	1911	1793	1560
9	3148	1883	1269	1259	1728	2256	1312
10	66	29	27	27	27	43	31
11	71599	61160	57894	60940	66397	61948	53945

ALDEHYDES (TONS/DAY)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	134.6	127.7	111.8	111.7	122.6	127.7	101.0
2	326.7	377.0	332.2	376.1	368.2	382.4	306.4
3	418.0	431.6	372.0	370.2	424.8	434.4	334.5
4	482.5	517.2	435.6	410.7	501.8	526.7	380.2
5	200.5	184.9	158.3	158.4	182.5	181.4	144.4
6	237.4	242.3	210.8	210.9	240.1	241.0	191.2
7	393.1	416.1	365.3	358.5	400.6	421.2	342.0
8	159.2	169.1	149.9	150.4	168.1	157.5	136.2
9	342.7	563.7	491.3	472.0	556.3	779.0	453.6
10	5.2	10.2	9.0	9.1	10.0	11.8	8.4
11	2699.9	3039.7	2635.9	2620.0	2975.0	3263.3	2398.7

MAXIMUM INCREMENTAL LAND (100 ACRES)

DR#	1972	REF	BAU W/C	AS W/C	ELEC	REG LIM	EAC
1	0	0	0	0	0	0	0
2	3082	2424	2303	2424	2479	2927	2753
3	7750	11035	10872	10905	11365	10153	10375
4	3316	3942	3756	3938	4184	3839	3572
5	4993	4519	4511	4475	4626	5248	5403
6	61	33	33	40	43	55	18
7	123	148	148	169	170	243	99
8	412	521	506	514	561	774	231
9	28	16	3	10	29	3	3
10	6	0	0	0	0	0	0
11	19774	22641	22136	22478	23463	23247	22453

TABLE 7-6

ASA'S WHERE ENERGY-RELATED CONSUMPTION IS GREATER THAN WATER AVAILABLE FOR ENERGY USE IN 20-YEAR LOW FLOW CASE

(Entries are energy-related consumption divided by water available for energy use for average annual flow case)

ASA	ASA NAME	1973	REFERENCE	BUSINESS-AS-USUAL WITH CONSERVATION	ACCELERATED SUPPLY WITH CONSERVATION	ELECTRIFICATION	REGIONAL LIMITATION	NAS	MEAN FLOW WATER AVAILABLE FOR ENERGY USE (CFS)
1305	Rio Grande Below Amistad	-	.70	.68	.72	.68	.71	.66	79
1503	Gila and Pedro-Salt	1.00	3.57	3.35	2.74	3.59	3.77	2.47	7
1601	Bear-Great Salt Lake	1.00	1.02	1.02	1.02	1.02	1.05	.97	35
1603	Humbolt-Tunopah Desert	1.00	1.72	1.69	1.78	1.67	1.75	1.63	3
1803	Tulare Basin-San Jouquin-Delta Central Sierra	.22	.24	.24	.23	.24	.24	.24	722
1805	Central Coastal California	.18	.18	.18	.18	.18	.18	.18	1491
1806	South Coastal California-Colorado	-	-	-	-	-	.24	-	393
1807	South Lahontan	1.00	1.06	1.03	1.01	1.02	1.08	1.04	15

1. Problem ASA's (those where energy water demand exceeds availability in the low-flow case) are, for the most part, the same ones which had problems in 1972. ASA 1305 is an exception, since it showed no supply problems in 1972.

2. ASA's exceeding supply are the same for all scenarios (except for Southern California under REG/LIM); in fact, there is comparatively little variation even in the amount of demand forecasted for different scenarios.

3. For 4 out of the 8 ASA's where energy-related water demand exceeds availability the shortage occurs only in the low-flow case, the mean flow easily providing an adequate supply of water. This observation suggests that variation in flows in these ASA's is a more critical factor than energy development.

4. Problems exist in ASA's 1503, 1601, 1603 and 1807, (all desert areas), where energy-related demand exceeds supply even in average flow conditions. In each of those ASA's however, the amount of water shortage involved is quite small.

The overall conclusion, then is that water is not an important consideration for the choice among scenarios.

7.3.3 Air Quality Comparisons

Comparison of scenario air quality effects on the basis of average population-weighted exposure reveals some differences among scenarios (see Tables 7-7 and 7-8). Although most Demand Region averages remain nearly constant over the range of scenarios, certain scenarios impact particular Demand Regions more heavily than others. For example, significant (more than 10 percent over other scenarios) differences in particulates averages occur in Demand Regions 7 and 8 in the Electrification scenario, and in Demand Regions 9 and 10 in the Regional Limitation scenario. Demand Region 7 under Electrification, and Demand Region 10 under Regional Limitation, are also affected by heavier SO_x exposure. The larger concentration averages under Electrification are attributable to greater use of coal for industry. The Regional Limitation impacts are due to higher levels of

TABLE 7-7

COMPARISON OF PARTICULATE AIR QUALITY

D.R.	REFERENCE	BUSINESS-AS-USUAL WITH CONSERVATION	ACCELERATED SUPPLY WITH CONSERVATION	ELECTRIFICATION	REGIONAL LIMITATION	EAC
1						
2	*			*	*	
3						
4	*			*	*	
5						
6				*		
7				**		
8				**		
9	*				**	
10					**	

* Indicates that the median of average population weighted exposure in this scenario is at least 10 percent greater than the minimum of all scenario median values in the Demand Region.

** Indicates that the median of average population weighted exposure in this scenario is at least 10 percent greater than the median value of all other scenarios for the Demand Region.

TABLE 7-8

COMPARISON OF SO_x AIR QUALITY

D.R.	REFERENCE	BUSINESS-AS-USUAL WITH CONSERVATION	ACCELERATED SUPPLY WITH CONSERVATION	ELECTRIFICATION	REGIONAL LIMITATION	EAC
1						
2						
3						
4						
5						
6						
7				**		
8						
9	*				*	
10					**	

* Indicates that the median of average population weighted exposure in this scenario is at least 10 percent greater than the minimum of all median values in the Demand Region.

** Indicates that the median of average population weighted exposure in this scenario is at least 10 percent greater than the median value of all other scenarios for the Demand Region.

electricity generation. Other Demand Regions expected to have elevated population-weighted particulates concentrations in the Electrification scenario are 2,4 and 6. Demand Regions 2 and 4 have elevated particulate concentrations under Regional Limitation.

The Reference scenario also appears to have greater air quality impact in some Demand Regions. Regions 2, 4 and 9 experience elevated population-averaged particulates concentrations, and Demand Region 9 has greater SO_x averages than most of the other scenarios. The greater impact of the Reference scenario on Demand Region 9 is most likely attributable to the proliferation of oil-fired power plants in that region for that scenario.

Because of the inconsistent geographic distribution of air quality monitoring stations in 1972 and 1974, comparisons among different Demand Regions in a given scenario cannot yield useful conclusions. For example, since there were only five monitoring stations in Demand Region 10, air quality data for this region is not comparable to that for other regions where more extensive and better distributed monitoring occurred. Therefore, no attempt is made to ascertain differences among Demand Regions on the basis of the Air Quality Model.

7.3.4 Comparison of Loadings from Uranium Fuel Cycle

Predicted radiation loadings for each 1985 scenario are shown in Table 7-9. These loadings are based on the assumption of "normal" operation (i.e., no nuclear accidents) and compliance with all radiation standards.

Radiation loadings for nuclear power plants are the same for all Demand Regions in the REF, AS/C and REG/LIM scenarios. The only significant difference between these scenarios and BAU/C occurs in Demand Region 9, where radiation loadings are about 30 percent lower. ELEC, a scenario characterized by greater power plant activity, exhibits higher curies loadings than any other scenario in all Demand Regions except 6 and 8, where they are the same, and 9, where they are about 30 percent lower. EAC exhibits uniformly lower loadings of curies in all Demand Regions.

Uranium 235 production (extraction, enrichment, fabrication and reprocessing) is the same for REF, AS/C, and REG/LIM, higher (by about 15 percent) in ELEC, slightly lower (by

TABLE 7-9

PREDICTED RADIATION LOADINGS

(In Curies unless otherwise noted)

DEMAND REGION	REFERENCE				BUSINESS-AS-USUAL WITH CONSERVATION				ACCELERATED SUPPLY WITH CONSERVATION			
	U-235 (tons/day)	MEDIUM			U-235 (tons/day)	MEDIUM			U-235 (tons/day)	MEDIUM		
	-	AIR	WATER	SOLIDS	-	AIR	WATER	SOLIDS	-	AIR	WATER	SOLIDS
1	.031	37.4	8.9	0	.031	37.4	8.9	0	.031	37.4	8.9	0
2	.086	104.8	25.0	0	.086	104.8	25.0	0	.086	104.8	25.0	0
3	.109	132.5	31.6	0	.109	132.5	31.6	0	.109	132.5	31.6	0
4	.089	109.0	26.1	0	.089	109.0	26.1	0	.089	109.0	26.1	0
5	.066	80.6	19.2	0	.061	75.0	18.0	0	.066	75.0	19.2	0
6	.023	28.4	6.8	0	.020	24.2	5.8	0	.023	24.2	6.8	0
7	.045	54.8	13.0	0	.342	52.0	12.4	0	.045	52.0	13.0	0
8	.014	16.9	4.0	0	.012	14.0	3.3	0	.014	14.0	4.0	0
9	.022	26.5	6.3	0	.015	18.2	4.3	0	.022	18.2	6.3	0
TOTAL FROM POWER PLANTS	USED .485	591.1	140.9	0	USED .468	574.9	136.2	0	USED .485	591.1	140.9	0
URANIUM FUEL CYCLE*	PRODUCED .485	143,888	978.6	236.0	PRODUCED .468	139,085	946.0	228.1	PRODUCED .485	143,888	978.6	236.0
NATIONAL TOTAL	-	144,479.2	1,119.6	236.0	-	139,655.5	1,082.3	228.1	-	144,479.2	1,119.6	236.0

*Except power plants

DEMAND REGION	ELECTRIFICATION				REGIONAL LIMITATION				ENVIRONMENTAL			
	U-235 (tons/day)	MEDIUM			U-235 (tons/day)	MEDIUM			U-235 (tons/day)	MEDIUM		
	-	AIR	WATER	SOLIDS	-	AIR	WATER	SOLIDS	-	AIR	WATER	SOLIDS
1	.039	47.1	11.3	0	.031	37.8	9.0	0	.027	32.9	7.9	0
2	.100	124.0	29.6	0	.086	104.9	25.0	0	.077	93.9	22.4	0
3	.129	157.8	37.7	0	.109	132.9	31.7	0	.066	80.5	19.2	0
4	.110	135.3	32.3	0	.089	108.6	25.9	0	.057	69.5	16.6	0
5	.075	90.9	21.7	0	.066	80.5	19.2	0	.017	20.7	4.9	0
6	.023	28.4	6.8	0	.023	28.1	6.7	0	.02	24.4	5.8	0
7	.048	58.8	14.1	0	.045	54.9	13.1	0	.009	11.0	2.6	0
8	.014	16.9	4.0	0	.014	17.1	4.1	0	.0035	4.3	1.0	0
9	.015	18.5	4.5	0	.022	26.8	6.4	0	.021	25.8	6.1	0
TOTAL FROM POWER PLANTS	USED .556	677.9	161.7	0	USED .485	591.7	141.1	0	USED .297	394.7	86.5	0
URANIUM FUEL CYCLE*	PRODUCED .556	165,028.6	1,122.4	270.6	PRODUCED .485	143,993.3	979.4	236.2	PRODUCED .295	[illegible]	[illegible]	147.4
NATIONAL TOTAL	-	165,706.5	1,284.1	270.6	-	144,585	1,120.5	236.2	-	90,284.8	697.9	147.4

*Except power plants

about 3 percent) in BAU/C, and substantially lower (by about 35 percent) in EAC. The differences in radiation loadings are proportional to those in production. The actual loadings are much larger in all media for production than for power plant utilization.

Since the loadings due to U-235 production are not disaggregated below the national level, and since no account is made of population exposure to the activity measured in curies, reliable Demand Region comparisons cannot be made, and scenario evaluations are limited to the gross comparison of national radioactivity loadings.

Table 7-10 presents loadings of non-radioactive pollutants from the entire uranium fuel cycle except nuclear power plants. Those loadings are those predicted for mining, milling, uranium hexaflouride production, fabrication, reprocessing and waste disposal. The loadings are low compared to those associated with other activities and are not significantly different among scenarios.

TABLE 7-10

POLLUTION LOADINGS FROM URANIUM FUEL CYCLE (EXCEPT NUCLEAR POWER PLANTS)

RESIDUAL	REF	BAU/C	AS/C	ELEC	REG/LIM	EAC
Acids (tons/day)	0	0	0	0	0	0
Bases (tons/day)	0	0	0	0	0	0
TDS (100 tons/day)	.4	.4	.4	.5	.4	.3
SS (tons/day)	0	0	0	0	0	0
Organics (100 tons/day)	0	0	0	0	0	0
Thermal (10^9 Btu/day)	0	0	0	0	0	0
Particulates (tons/day)	2.6	2.5	2.6	2.9	2.6	1.6
NO_x (tons/day)	11.7	11.3	11.7	13.4	11.7	7.2
SO_x (tons/day)	13.0	12.6	11.7	14.9	13.0	8.0
Hydrocarbons (tons/day)	1.0	.9	.9	1.2	1.0	.6
CO (tons/day)	.1	.1	.1	.1	.1	.1
Aldehydes (tons/day)	.4	.4	.4	.4	.4	.2
Solids (1000 tons/day)	39.3	38.0	39.3	45.2	39.3	24.2
Fixed Land (100 acres)	826.1	794.5	826.1	947.4	826.1	508.4
Max. Inc. Land (100 acres)	0	0	0	0	0	0

CHAPTER EIGHT

CONCLUSIONS

8.1 The Models

The environmental residuals technique employed by the models used in this analysis has proven to be a useful working tool in the evaluation of energy development scenarios. A distinction must be made between the analysis of local impacts due to specific development activities (e.g., expansion of a coal-fired power plant along a major river) and the evaluation of the broader-scale policy issues of Project Independence. The residuals technique addresses the latter problem in an effort to quantify the relative effects that different scenarios will have on various regions.

The major advantage of this modeling approach is that it compares environmental effects by objective, quantitative criteria. Moreover, the models' output may be surveyed over a wide range of geographic scales, enabling the environmental assessment of energy policies at the same geographic level as that for which they were formulated. Enough detail is present to allow the identification of regions where the damages wrought by energy development may be excessive and which need more in-depth study. It is in this context of broad-scope regional comparisons, relatively free from subjectivity, that the results of the residual allocation model and its peripheral air and water models are most valid and most useful.

The emphasis on regional comparisons is made because of the difficulty and uncertainty involved in predicting site specific activities. Even aside from the tradeoffs between detail and comprehensibility of the results (which affect the manner of presentation), there is a limit of geographic detail beyond which reliable information concerning future patterns of resource extraction, facility siting, and fuel consumption simply is not available to support finer disaggregation. For this reason, the allocation of residuals goes no further than the river basin or AQCR level with no explicit consideration of topography, climate, or severity of particular point sources.

The residuals technique has been used on four sets of scenarios (national energy policy alternatives) and has proved to be a useful tool in that application. Furthermore, the technique appears to have utility beyond this particular analysis. There is no reason why similar approaches cannot be used on finer (e.g., an EPA region) or broader (even global) scales. All that is required are the levels of the activities of interest and the residual coefficients corresponding to those activities and regions under study. Other residuals may be included or some may be deleted. Other time frames are possible, and different activities (not necessarily energy-related) may be considered.

The technique is simple and easily applied, the most difficult phase being the collection of meaningful data for surrogate measures. The only restrictions on its development and use are that for all segments of the analysis a consistent level of detail or accuracy be applied and that the results be used for comparative purposes rather than absolute predictions.

Obviously, a crucial concept in the residuals technique is that of a "residual." The 15 residuals allocated by the model comprise relatively broad classes of environmental damage. For example, predictions of loadings in organics do not distinguish between chemically different hydrocarbons. Loadings estimates for solids lump together all pollutants which do not enter the air or water. They include such different wastes as spent shale from oil shale processing and scrubber sludge from power plants. Residuals provide a convenient, allocable set of loadings categories by which the overall effects of energy development stragegies can be compared.

8.2 Specific Observations Based on Scenario Analysis

Application of the models to four sets of national energy supply and demand scenarios has yielded several specific conclusions regarding particular regions, pollutants, and activities. Among these are:

1. Three Demand Regions -- the South Atlantic, Mountain, and Alaska Regions -- will be especially impacted by energy development. In the South Atlantic Region almost all energy activities exhibit substantial growth in all scenarios; the most striking increases are in surface coal mining, oil and gas production, refining, oil-fired power generation, and industrial end use. The Mountain Region shows greatly increased levels of surface coal mining, shale oil production

(except in the EAC scenario), coal-fired power generation, industry, and residential and commercial fuel consumption. The dominant energy activity in Alaska is oil production, which increases at least an order of magnitude (twenty-fold in some cases) in all scenarios.

2. Water use for energy activities does not afford a basis for choosing among scenarios; moreover, energy-related water requirements are not a significant constraining factor in energy development. Only a few areas can be considered water-constrained in the scenarios, and each of these is characterized by at least one of the following:

   a. Water shortages occur only in the twenty-year low flow case, suggesting that variation in flow is the critical factor;

   b. Non-energy related activities impose far greater restrictions on water availability than energy related activities; or

   c. There is not much water in the region for any activities, and any significant increases would lead to water shortages. In these cases the shortages are small in absolute volume.

3. Several energy activities can be identified as major contributors to environmental damage (Figure 8-1). These are listed below along with their most characteristic associated residuals:

   a. Coal-fired power plants (water pollutants, NO_x, SO_x, particulates, solids);

   b. Refineries (water pollutants, SO_x, solids);

   c. Oil-fired power plants (water pollutants, NO_x, SO_x, particulates);

   d. Transportation gasoline use (NO_x, particulates, and especially carbon monoxide, hydrocarbons, and aldehydes);

   e. Industrial coal use (particulates, SO_x); and

   f. Coal mining (TDS, suspended solids, solids, and maximum incremental land).

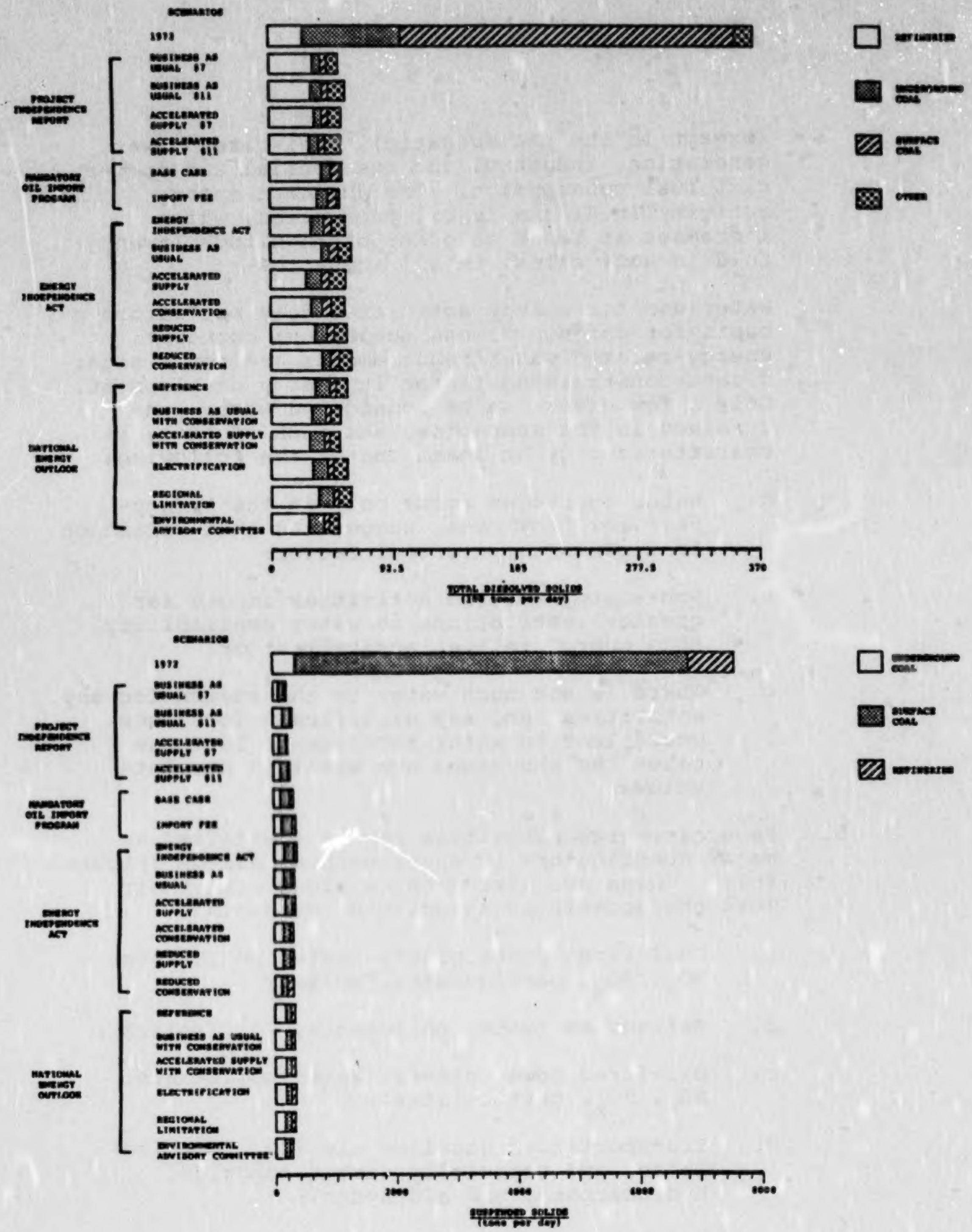


FIGURE 8-1

1972 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES

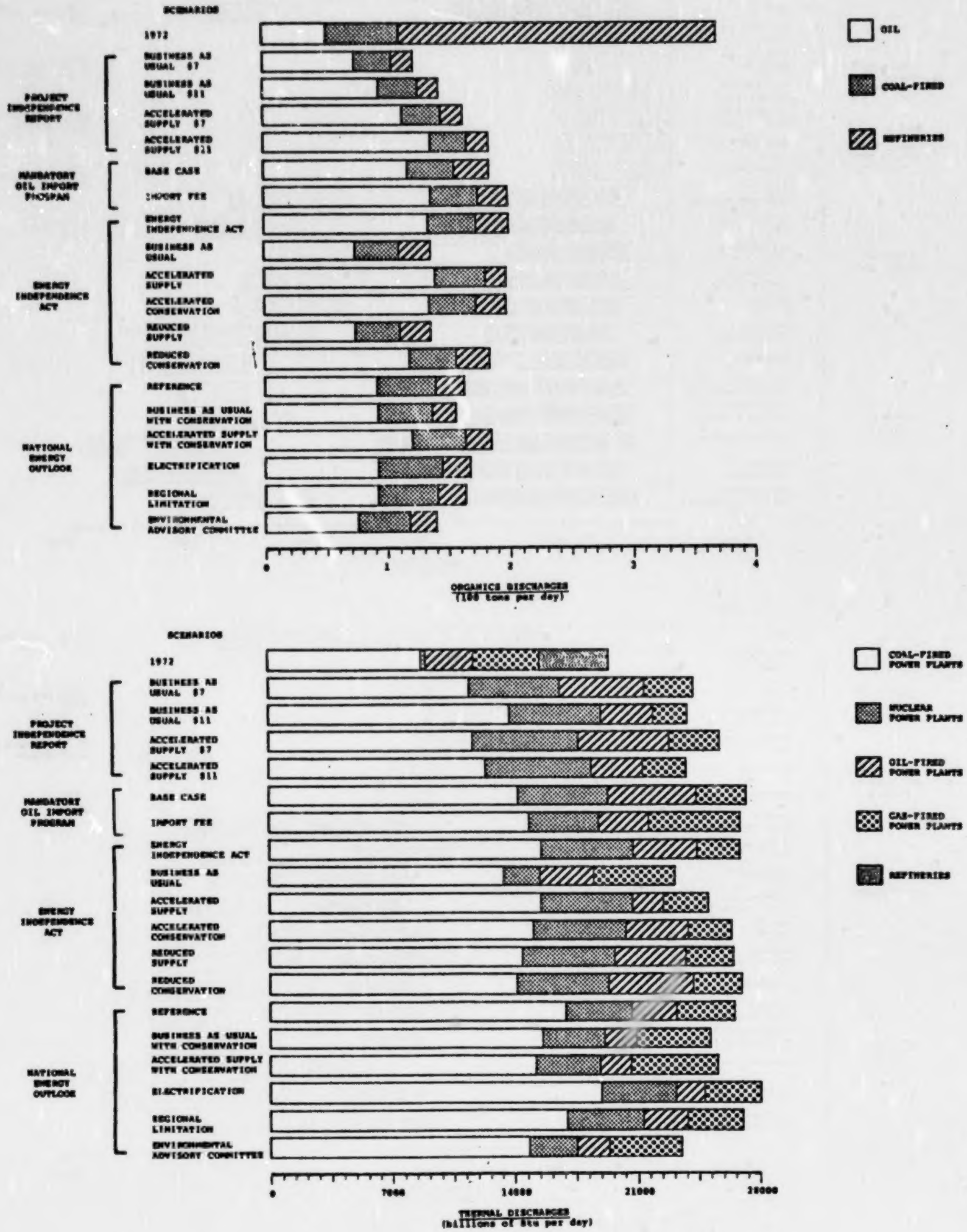
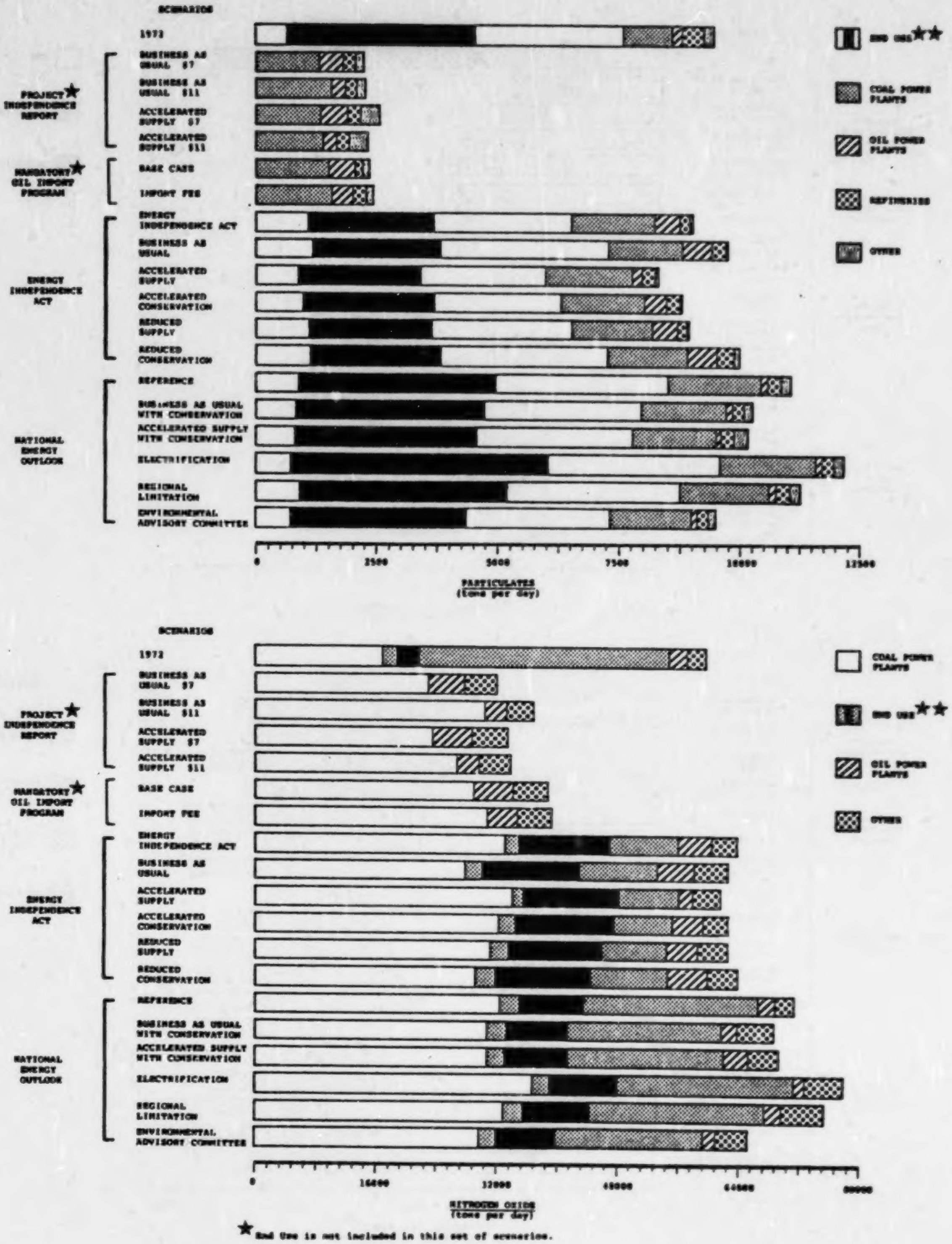


FIGURE 8-1 (CONT.)

1975 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES

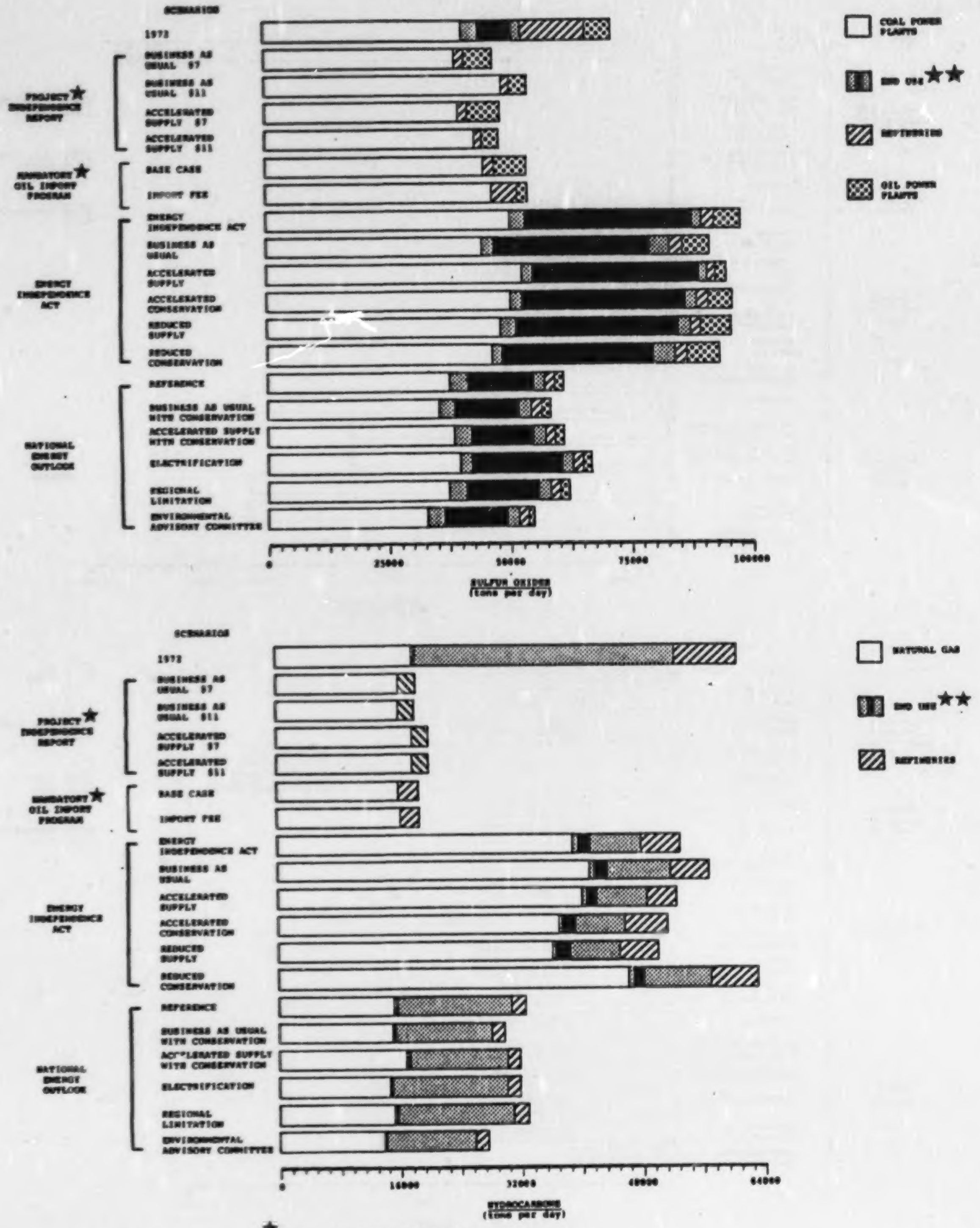


★ End Use is not included in this set of scenarios.

★★ End Use is divided into 1 2 3 1) Household/Commercial, 2) Industrial and 3) Transportation.

FIGURE 8-1 (CONT.)

1975 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES

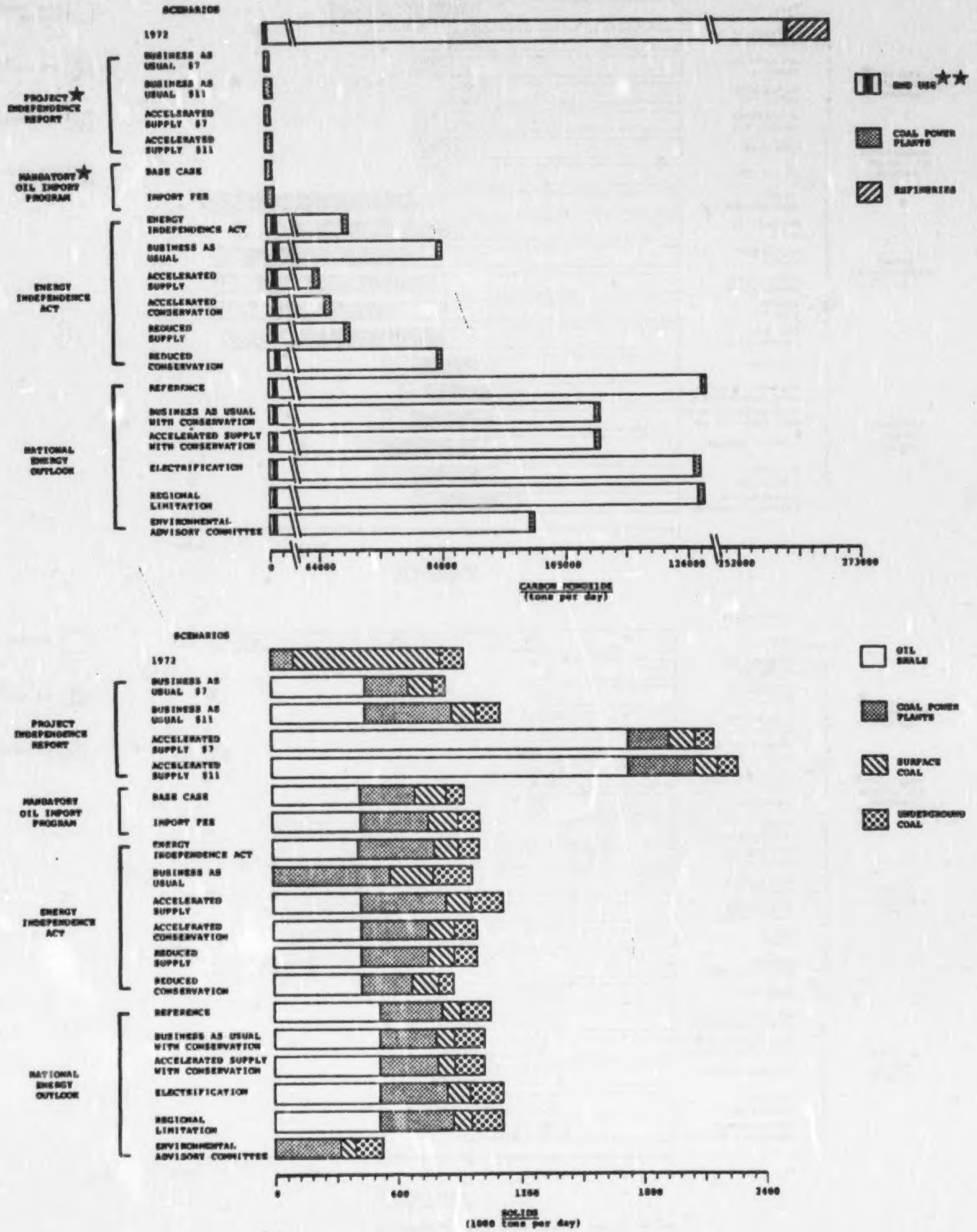


★ End Use is not included in this set of scenarios.

★★ End Use is divided into 1 2 3 1) Household/Commercial, 2) Industrial and 3) Transportation.

FIGURE 8-1 (CONT.)

1975 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES



★End Use is not included in this set of scenarios.

★★End Use is divided into ▯ 1) Household/Commercial, 2) Industrial and 3) Transportation.

FIGURE 8-1 (CONT.)

1975 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES

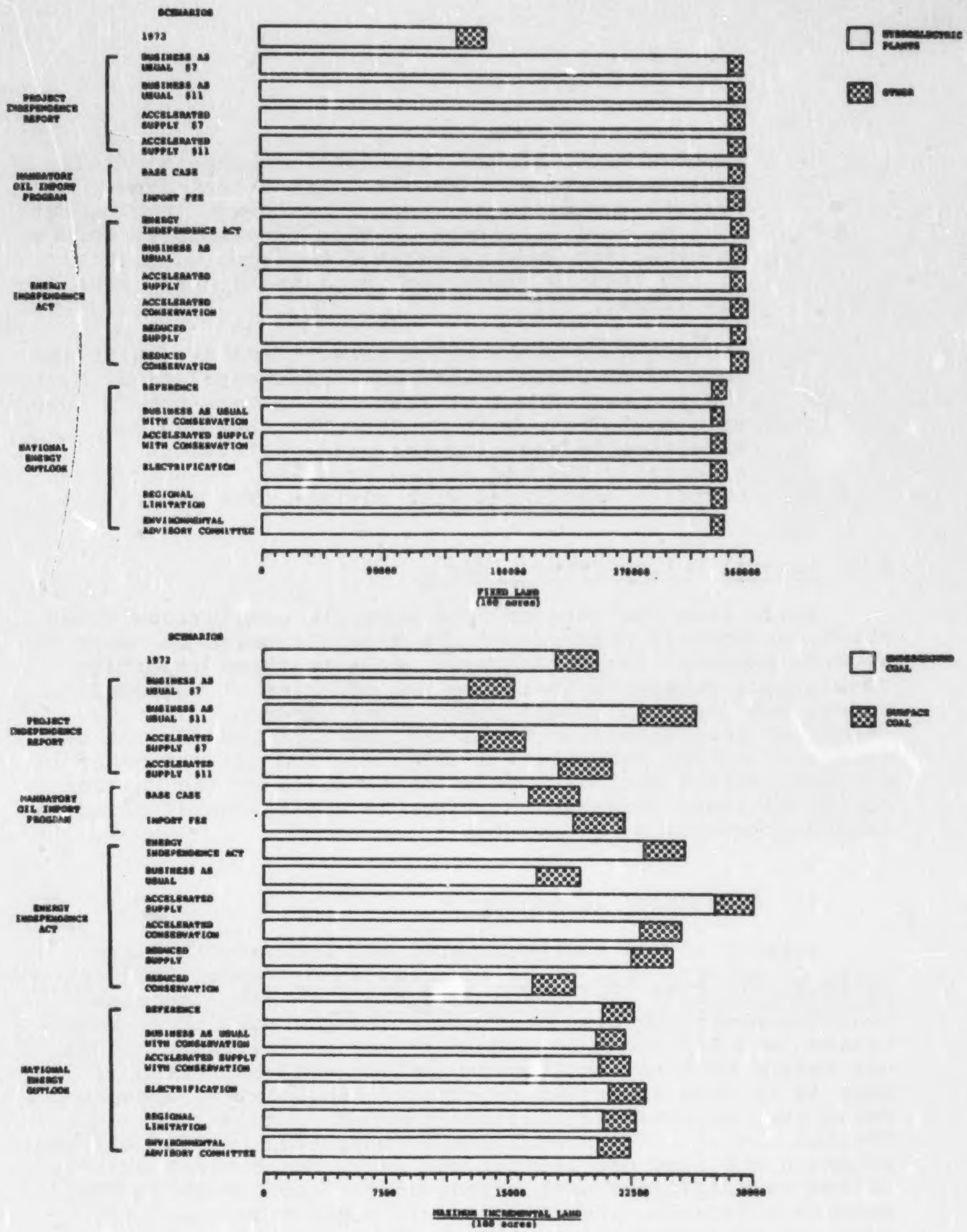


FIGURE 8-1 (CONT.)

1975 AND PROJECTED 1985 NATIONAL POLLUTION LOADINGS FROM ENERGY ACTIVITIES

These activities are important components of all energy scenarios. Efforts to ameliorate the overall environmental impact of energy development will be most effective if they successfully reduce the specific impacts related to these activities in the regions where levels of these activities are significant.

4. Surface mine reclamation laws, formulated with the purpose of reducing maximum incremental land, have the further effect of reducing surface runoff into streams. The result is that the laws can be effective in reducing the water pollutants -- especially TDS and suspended solids -- which are normally associated with surface coal mining.

8.3 General Policy Conclusions

Aside from the more or less specific conclusions drawn above, an overall analysis of the models results in terms of general scenario characteristics leads to three important conclusions regarding environmental policies of national energy development. These conclusions concern: (1) the degree of pollution control technology implemented, (2) the effect of energy conservation policies, and (3) the benefits of imposing the stringent measures proposed by the Environmental Advisory Committee to ease the environmental pressures caused by energy development.

8.3.1 Control Technology

Results of the analyses performed indicate that the level of control applied is the single most important factor in affecting 1985 environmental quality -- more important than the amount or distribution of energy (and other) activities (see Section 4.5). This is not to say that it does not matter what national energy policy will be, but only that it is more important to enforce the existing and proposed environmental regulations assumed in this model (see Section 1.4.1). (The regulations considered reflect effluent, emission and land use limitations only, not ambient standards. To assure compliance with standards for each scenario would require a dynamic, iterative model, capable of computing absolute environmental quality.) Moreover, to the extent that the regulations may be relaxed (either the limitations or time to achieve) in order to accommodate increased energy development, there will be a two-edged adverse environmental impact compared to baseline forecasts due to (1) the extra activity, and (2) the less stringent environmental control. In other words, existing and proposed environmental regulations are aimed, at least to some extent, at achieving ambient standards in the future for some baseline growth projection. A national energy policy that exceeds this growth projection may cause standards to be violated. In addition, if emission or effluent guidelines are relaxed there will be an increased risk that standards will be violated. The implications of this can be modeled only if residual coefficients are varied with the scenario to reflect the tradeoffs between energy development and environmental quality.

8.3.2 Energy Conservation

Comparison of the conservation scenarios with the others in terms of residual loadings indicates that energy conservation policies, if successfully implemented, offer an effective means for reducing the environmental impacts associated with energy production as well as consumption. The energy conservation measures assumed by the model include energy efficiency standards for automobiles, new buildings, and appliances; improved airline load factors; a national van pool program; electric utility load management; accelerated industrial conservation; and other similar actions. As such, the conservation scenarios reflect aggressive but hopefully achievable policies designed to reduce the demand for energy, a goal which will lead to reduced supply of energy as well. Fuel consumption (including that for electricity generation) is by far the dominant source of most of the residuals. Conservation then has three significant attributes. First, it is an economical and achievable policy that will help meet the national energy balance. Second, it strikes hardest in terms of environmental control at that sector (end use consumption) that produces the greatest amounts of the most serious pollutants. Third, it has the effect of reducing energy supply requirements, thus activities, thus finally residuals.

8.3.3 Environmental Measures

Evaluation of the EAC scenario in terms of the other scenarios shows that stringent environmental measures of the type proposed by the Environmental Advisory Committee are effective in reducing both demand/supply levels and pollution loadings even further than conservation policies alone. (It should be noted that these are initiatives of the Environmental Advisory Committee, not EPA.) The measures incorporated in the full EAC scenario analyzed for this report go beyond the conservation policies discussed above and include imposing a Btu tax on energy consumption, a sulfur emissions tax, and a more stringent automobile efficiency standard, abandoning oil shale extraction, and reducing emphasis on surface coal mining. The results of these policies include substantially lower demand for all fuels than in the conservation scenarios, less coal-fired and nuclear power generation, less domestic refining, and reduced levels of land use-impacting supply activities, all leading to lower associated residual loadings nationwide.

APPENDIX A

REGIONAL ANALYSIS FOR PROJECT INDEPENDENCE REPORT

A.1 Introduction

Although the analysis of each 1985 scenario showed either a decline or only a slight increase in most national pollution loadings due to increased energy activities, the distribution of these loadings across different regions of the country is not uniform. In addition, the impacts of pollutants vary among regions depending on the topography, climatology, vegetation and land use. This section presents an analysis of the regional aspects. Of course, there will also be significant differences among areas within a region. For example, although a region may experience reduction in pollution loadings, certain areas within the region may experience increased loadings. A more comprehensive subregional analysis would yield still further insights into the environmental aspects of the FEA scenarios.

The FEA model predicts levels of different energy activities, thus pollution loadings, within different geographic areas for different activities. These geographic areas do not have common boundaries. The regional analysis in this section results from a model, developed for this project, which allocates energy production and the pollutant loadings resulting therefrom to 140 areas for energy extraction and to 335 areas for energy conversion within the continental United States. These loadings are then reaggregated into the regional loadings. A detailed description of the model is in Chapter 2. The underlying assumptions of the model are:

- energy material extractions will occur in proportion to past extractions and/or reserves, and
- energy facilities will be sited on the basis of existing facilities, plus planned facilities, minus planned retirements.

One peculiarity of the FEA model is that oil-fired turbines are combined with oil-fired steam-electric plants. Thus, electricity production for turbines is shown as zero in all production tables.

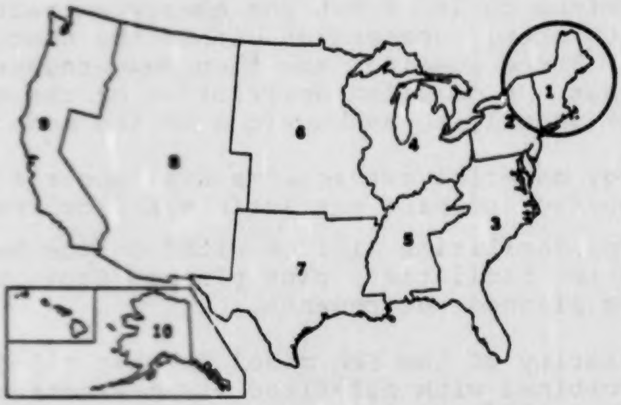
In order to insure consistency with other aspects of the Project Independence Blueprint, the regions used for this analysis are the Demand Regions defined by FEA. However, the model is capable of aggregating pollutants according to several different regional definitions such as EAP Regions, Census Regions or even states.

Tables A-1 to A-10[1] show bar charts of selected pollution loadings for each Demand Region.

In the following analysis, major regional impact were selected on the basis of any one of these criteria:

1. a large proportion of energy-related national pollution loadings;
2. significant changes from 1972 in total loadings of a given pollutant;
3. development of virgin areas or new types of energy processes (e.g., new OCS areas, coal gasification or oil shale);
4. significant changes from 1972 pollution loadings from any specific energy activity; or
5. a large proportion of a pollution loading due to one specific energy activity.

A.2 Demand Region 1 - Northeast



DEMAND REGIONS

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[1] In the bar charts, lack of any bar for a particular entry indicates a small quantity of that pollutant in that region under that scenario. For any given pollutant, all bars for all regions are at the same scale.

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TABLE A-1

DEMAND REGION 1

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	0	0	0	0	0	(E3 TONS/DAY)
UNDERGROUND COAL	0	0	0	0	0	(E3 TONS/DAY)
NATURAL GAS	0	21.2908	21.2908	183.326	183.326	(E6 SCF/DAY)
OIL	0	14.0621	14.0621	182.882	182.882	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	0	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS						
COAL-FIRED	4.08539	13.8539	40.9029	18.0832	32.5603	(E3 TONS/DAY)
OIL-FIRED	375.884	512.38	133.379	499.169	132.587	(E3 BBLS/DAY)
GAS-FIRED	127.644	9.75049	5.57199	9.75049	5.57199	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	7.48107E-3	5.03368E-2	5.03368E-2	5.87262E-2	5.87262E-2	(TONS U-235/DAY)
HYDROELECTRIC	1.25881	9.50337	9.50337	9.50337	9.50337	(E3 MWATTS)
REFINERIES	0	0	0	0	0	(E3 BBLS/DAY)

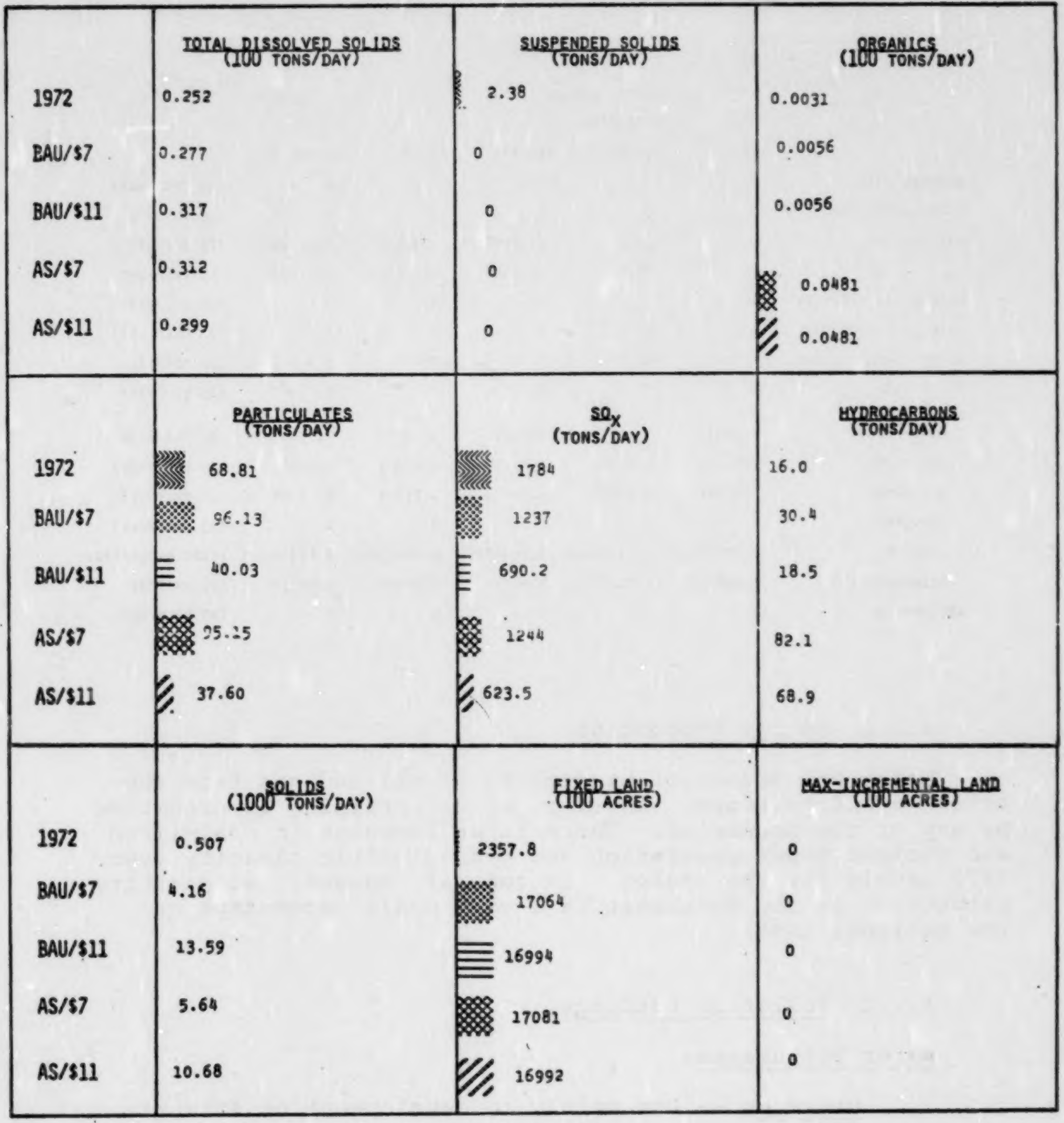
A.2.1 Energy Production

Under all scenarios production of oil and gas from the Atlantic OCS is begun. However, no oil refining is predicted by any of the scenarios. There is an increase in coal-fired and nuclear power generation and hydroelectric capacity over 1972 levels for the region. In general, however, electricity production in the Northeast is a very small percentage of the national total.

A.2.2 Pollution Loadings

Water Pollutants:

Organics -- Due mainly to development of Atlantic OCS, organics loadings increase substantially in all 1985 scenarios.



	TOTAL DISSOLVED SOLIDS (100 TONS/DAY)	SUSPENDED SOLIDS (TONS/DAY)	ORGANICS (100 TONS/DAY)
1972	0.252	2.38	0.0031
BAU/$7	0.277	0	0.0056
BAU/$11	0.317	0	0.0056
AS/$7	0.312	0	0.0481
AS/$11	0.299	0	0.0481

	PARTICULATES (TONS/DAY)	SO_x (TONS/DAY)	HYDROCARBONS (TONS/DAY)
1972	68.81	1784	16.0
BAU/$7	96.13	1237	30.4
BAU/$11	40.03	690.2	18.5
AS/$7	95.25	1244	82.1
AS/$11	37.60	623.5	68.9

	SOLIDS (1000 TONS/DAY)	FIXED LAND (100 ACRES)	MAX-INCREMENTAL LAND (100 ACRES)
1972	0.507	2357.8	0
BAU/$7	4.16	17064	0
BAU/$11	13.59	16994	0
AS/$7	5.64	17081	0
AS/$11	10.68	16992	0

FIGURE A-1

REGIONAL POLLUTION LOADINGS

NORTHEAST

Thermal -- Thermal pollution increases over 1972 60 to 70 percent in the $7 scenarios, while decreasing slightly in the $11 scenarios. The differences between the $7 and $11 scenarios are due mainly to wide variations in the changes from 1972 of oil-fired power generation. Oil-fired power generation increases over 1972 30 to 40 percent in the $7 scenarios, while falling 60 to 70 percent in the $11 scenarios. Most of the increase at $7 is due to nuclear power plants, which also offset most of the decrease at $11.

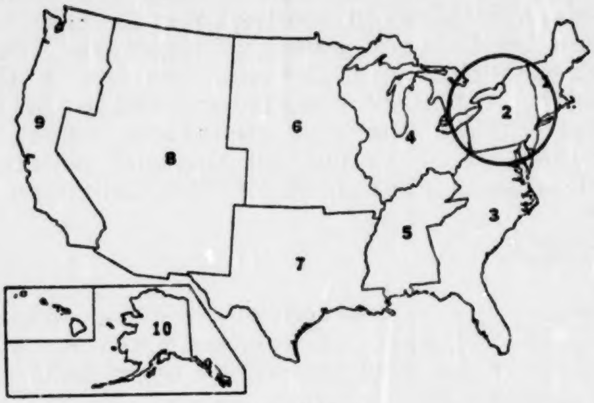
Air Pollutants:

Hydrocarbons -- Due mainly to the development of Atlantic OCS natural gas production, hydrocarbon loadings rise significantly over 1972 in all four 1985 scenarios.

A.2.3 Addenda

The development of the virgin Atlantic OCS for the production of oil and natural gas, as well as the implied increased oil tanker traffic, requires consideration of the impacts on marine and estuarine ecosystems, beaches, and commercial and recreational fishing.

A.3 Demand Region 2 - Mid-Atlantic



DEMAND REGIONS

Table A-2

DEMAND REGION 2

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	71.788	74.0447	74.0447	74.0447	74.0447	(E3 TONS/DAY)
UNDERGROUND COAL	136.178	75.5524	79.269	75.5524	75.5524	(E3 TONS/DAY)
NATURAL GAS	211.89	145.114	146.878	157.035	157.035	(E6 SCF/DAY)
OIL	11.9616	11.202	18.4013	11.1249	11.1249	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	0	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS						
COAL-FIRED	61.1906	117.47	296.714	128.287	241.949	(E3 TONS/DAY)
OIL-FIRED	231.3	345.796	201.446	361.747	179.549	(E3 BBLS/DAY)
GAS-FIRED	4.65753E-2	3.51257E-3	2.00729E-3	3.51257E-3	2.00729E-3	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	2.19169E-3	6.29936E-2	6.29936E-2	7.41187E-2	7.41187E-2	(TONS U-235/DAY)
HYDROELECTRIC	5.97565	17.1966	17.1966	17.1966	17.1966	(E3 MWATTS)
REFINERIES	1415.6	1750	1750	1750	1750	(E3 BBLS/DAY)

A.3.1 Energy Production

Energy production in the Mid-Atlantic remains near 1972 levels except for large increases in coal-fired and nuclear electricity generation, and a decline in underground coal production.

A.3.2 Pollution Loadings

Water Pollutants:

Total Dissolved Solids -- Due to increased controls on and reduced production from underground coal mining, total dissolved solids are reduced from 1972 by two thirds in all four 1985 scenarios.

Suspended Solids -- Due to increased controls on suspended solids from surface and underground coal mining, total suspended solids are reduced from 1972 in all four 1985 scenarios.

Thermal -- Thermal pollution increases by 50 percent over 1972 in all four 1985 scenarios. This is due mainly to two factors: (1) a doubling for the $7 scenarios and quadrupling for the $11 scenarios of coal-fired electricity generation, and (2) a thirty-fold increase in nuclear power generation in all four 1985 scenarios.

These increases are somewhat offset by a total reduction through increased controls on thermal pollution from refineries.

Air Pollutants:

Nitrogen Oxide -- Nitrogen oxide increases by 50 percent over 1972 in the $7 scenarios, and by 100 percent over 1972 in the $11 scenarios. These increases are almost entirely attributable to increases in electricity generation from coal-fired power plants.

Carbon Monoxide -- Carbon monoxide pollution is reduced from 1972 by 90 percent for the $7 scenarios and by 80 percent for the $11 scenarios. These reductions are almost entirely attributable to increases in carbon monoxide controls on refineries. Differences between the $7 and $11 scenarios are accounted for by the greater coal-fired power generation in the latter.

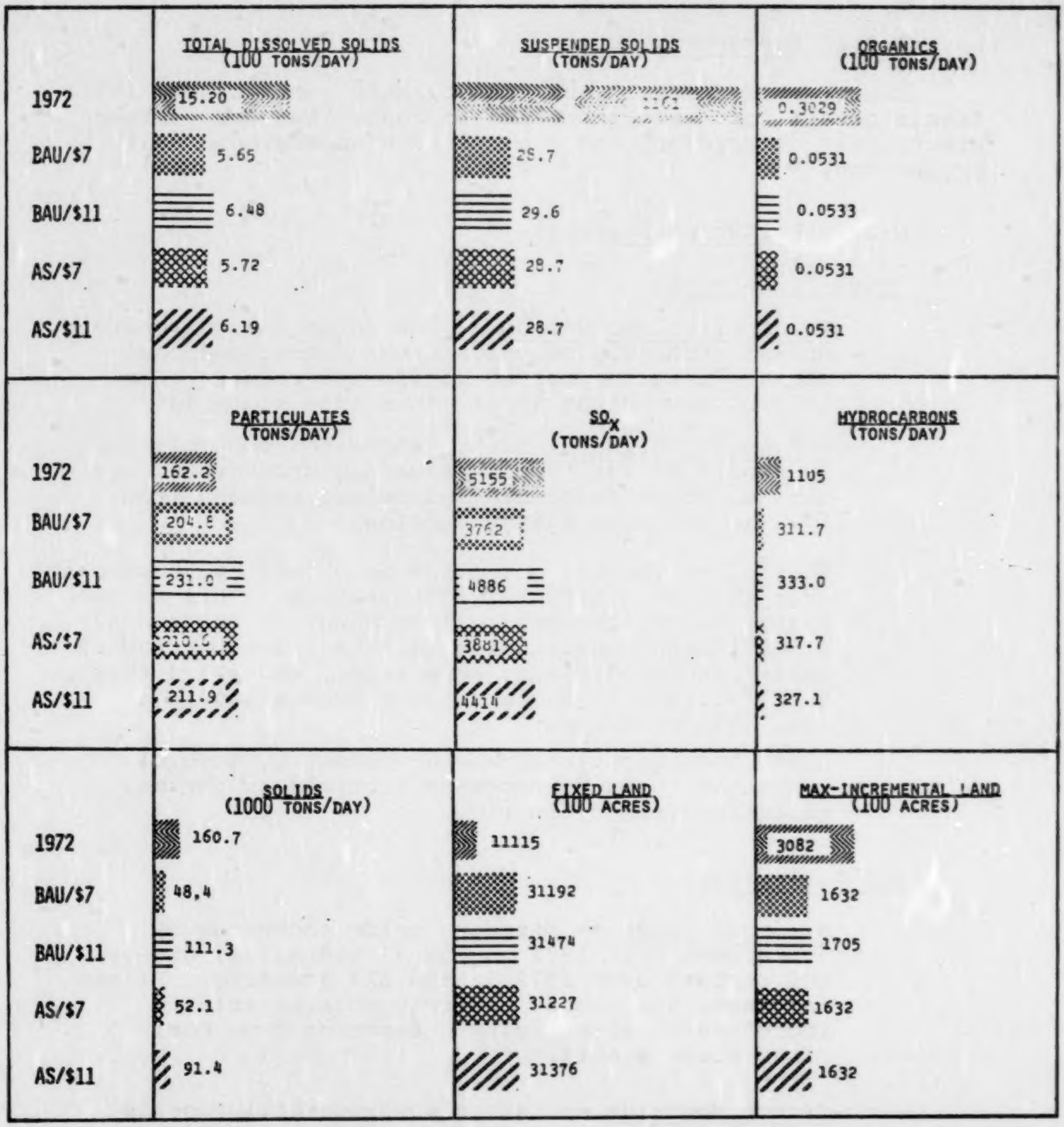


FIGURE A-2

REGIONAL POLLUTION LOADINGS

MID-ATLANTIC

Land Use:

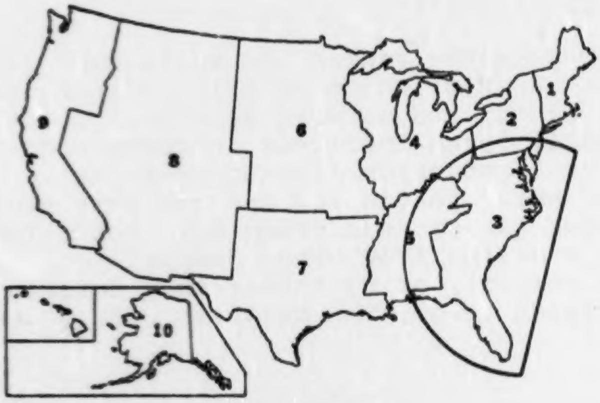
Maximum Incremental Land -- Maximum incremental land is reduced by nearly 50 percent from 1972 in all four 1985 scenarios. These reductions are entirely attributable to increases in strip-mine reclamation, and decreases in underground coal mining.

A.3.3 Addenda

Since ambient air quality in 1972 exceeded primary standards for SO(X) and particulates, even small increases in these pollutants will make the achievement of standards in 1985 difficult. Similarly, significant increases in NO(X) may also threaten achievement of standards. The increased air pollutant loadings in this region which already has ambient air quality problems could pose a threat to human health. This is especially important due to the high population density. To the extent that advanced control technology is not applied, health hazards would be increased.

Due to existing water supply and quality problems, the increased thermal pollution loadings could be a critical concern.

A.4 Demand Region 3 -- South Atlantic



DEMAND REGIONS

TABLE A-3

DEMAND REGION 3

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	77.816	269.276	269.276	269.276	269.276	(E3 TONS/DAY)
UNDERGROUND COAL	358.118	75.3344	201.642	71.24	71.24	(E3 TONS/DAY)
NATURAL GAS	565.764	1601.7	1602.71	2080.22	2080.22	(E6 SCF/DAY)
OIL	53.6356	170.648	205.156	475.262	475.262	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	0	139.2	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	24	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS						
COAL-FIRED	281.954	306.05	467.927	312.143	380.417	(E3 TONS/DAY)
OIL-FIRED	447.538	1294.13	889.328	1424.5	893.515	(E3 BBLS/DAY)
GAS-FIRED	275.934	41.0881	41.0881	41.0881	41.0881	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	7.96107E-3	0.155642	0.155642	0.182811	0.182811	(TONS U-235/DAY)
HYDROELECTRIC	2.46566	13.923	13.923	13.923	13.923	(E3 MWATTS)
REFINERIES	432.45	6471.78	5446.25	6583.21	3661.53	(E3 BBLS/DAY)

A.4.1 Energy Production

In the South Atlantic region under all scenarios, all energy extraction and production activities increase except underground coal mining and natural gas-fired power generation. There are especially large increases in surface coal mining, oil and natural gas production (including Atlantic OCS), nuclear and hydroelectric power generation and refinery production. Oil refining throughout far exceeds crude oil production into the region either by pipeline from other domestic oil fields (e.g., from the Gulf of Mexico), or by tanker from foreign sources or other domestic fields (e.g., the Atlantic OCS in Demand Region 1).

A.4.2 Pollution Loadings

The large increase in energy activities in this region could cause standards to be violated. Figures A-2 through A-5 show that several areas in this demand region exceeded primary air quality standards in 1972 and will experience increased loadings in 1985 for particulates and/or SO(X).

Water Pollutants:

Bases, total dissolved solids, suspended solids, and thermal pollution of water in demand region 3 all account for approximately 20 percent or more of their respective national pollution totals in each scenario.

Suspended Solids -- Suspended solids decrease over 95 percent from 1972 for all four 1985 scenarios. These decreases are almost entirely accounted for by increases in surface and underground coal mining controls for suspended solids, coupled with cuts in production from underground coal mines. Suspended solids pollution is highest in the $11 Business-as-Usual scenario than in the other scenarios due to a greater level of underground coal mining production.

Organics -- Substantial reductions from 1972 in organics pollution of water in all four 1985 scenarios are due mainly to increased controls on coal-fired power plants. These reductions, however, are somewhat offset by increases in organics pollution due to the three- to ten-fold increase (depending on the scenario) in oil production caused by development of Atlantic OCS.

Thermal -- Thermal pollution increases by more than 50 percent over 1972 for all four 1985 scenarios. In each case the majority of this increase is attributable to a twenty-fold rise in nuclear power generation. Increases in coal- and oil-fired electricity generation account for more than 40 percent of the overall increase.

Air Pollutants:

Particulates, nitrogen oxide, sulfur oxide, carbon monoxide and aldehydes pollution in Demand Region 3 all account for approximately 20 percent or more of their respective national pollution totals in each scenario.

Particulates -- Particulate loadings increase 50 percent over 1972 in all four 1985 scenarios. These rises are due almost entirely to a doubling in the $11 scenarios and trebling in the $7 scenarios of electricity generation from oil-fired power plants, and a ten- to fifteen-fold increase in refinery production for each scenario.

Hydrocarbons -- Hydrocarbons increase two- to three-fold over 1972 in all four 1985 scenarios. These rises are due in part to a ten- to fifteen-fold increase in refinery production. They are also partly attributable to a trebling in the Business-as-Usual scenarios and quadrupling in the Accelerated Supply scenarios of natural gas production. This new production is due mainly to development of the Atlantic OCS.

Aldehydes -- Aldehyde loadings rise five- to seven-fold over 1972 in the $11 scenarios, and nine-fold in the $7 scenarios. These increases are almost entirely due to increases in refining production.

Land Use:

Solids -- Generation of solids decreases from 1972 over 50 percent for the $7 scenarios, and 25 to 40 percent for the $11 scenarios. These decreases are due largely to increases in controls over solid waste generation from surface coal mining.

Maximum Incremental Land -- In all four 1985 scenarios, maximum incremental land use declines from 1972 levels, but accounts for over 20 percent of the national total.

A.4.3 Addenda

The especially high levels of new energy development in this region will require considerations outside the scope of the analysis, including the depletion of water supplies, the development of virgin OCS areas, the siting of energy facilities and the inducement of secondary development.

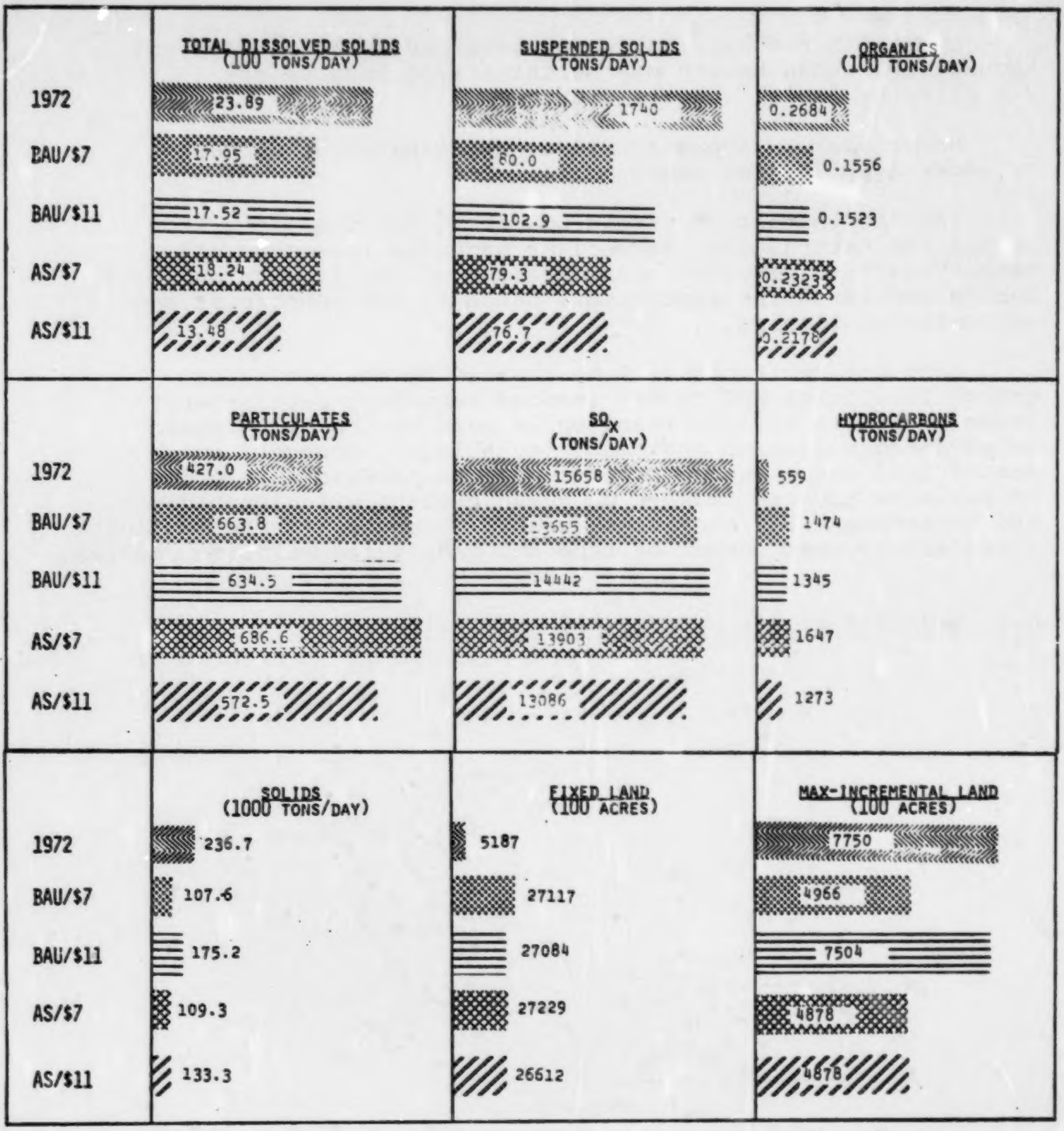


FIGURE A-3

REGIONAL POLLUTION LOADINGS
SOUTH ATLANTIC

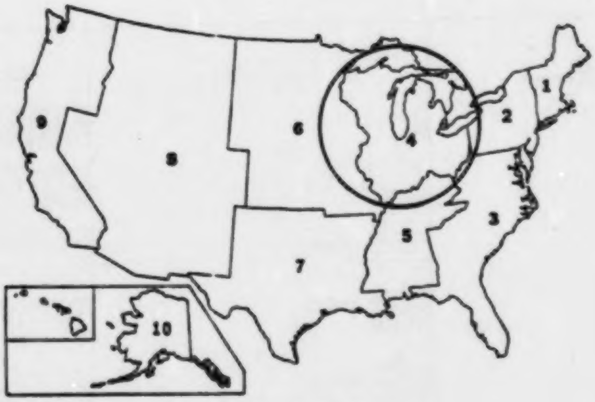
Even with the application of advanced pollution control technology, human health may be threatened because of violation of health related standards.

Water quality impacts will be exacerbated by depletion of water supplies for energy use.

The development of virgin OCS areas for the production of oil and natural gas, as well as probable increased oil tanker traffic, requires consideration of the impacts on marine and estuarine ecosystems, beaches, and commercial and recreational fishing.

Land use conflicts will be created by the siting of energy facilities and by the induced secondary development. These conflicts will be resolved in part by the application of advanced pollution abatement technology. However, an active land use planning process will be necessary in order to minimize adverse impacts on human health, wildlife habitat, and environmentally sensitive areas. Moreover, in the Southeast there are a great number of rare and endangered wildlife species.

A.5 Demand Region 4 - East North Central



DEMAND REGIONS

TABLE A-4

DEMAND REGION 4

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	252.875	402.757	402.757	402.757	402.757	(E3 TONS/DAY)
UNDERGROUND COAL	136.767	111.173	437.852	163.598	364.935	(E3 TONS/DAY)
NATURAL GAS	371.389	1573.28	1592.41	1702.51	1702.51	(E6 SCF/DAY)
OIL	173.584	121.48	199.553	120.644	120.644	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	0	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS COAL-FIRED	257.712	282.647	385.476	300.616	354.723	(E3 TONS/DAY)
OIL-FIRED	43.1917	342.525	122.292	452.204	119.267	(E3 BBLS/DAY)
GAS-FIRED	193.332	53.7314	53.7314	53.7314	53.7314	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	1.23655E-2	0.11416	0.11416	0.133167	0.133167	(TONS U-235/DAY)
HYDROELECTRIC	0.753819	7.24848	7.24848	7.24848	7.24848	(E3 MWATTS)
REFINERIES	2108.3	585.028	828.318	570.689	592.907	(E3 BBLS/DAY)

A.5.1 Energy Production

Surface coal production increases by 60 percent under all scenarios. Despite this 60 percent increase, the region's percentage of the national total of surface coal production drops from 33 percent in 1972 to 20 to 25 percent in 1985. Underground coal production increases substantially under the $11 scenarios. Hydroelectric and oil-fired power generation increase substantially under all scenarios.

A.5.2 Pollution Loadings

Although coal mining increases substantially, the application of control technology causes a decline in most water pollution loadings.

Water Pollutants:

Bases and suspended solids account for approximately 20 percent or more of their respective natioanl pollution totals in each scenario.

Bases -- Bases increase two- to three-fold in the $7 scenarios, and three- to four-fold in the $11 scenarios. These increases are due entirely to increases in surface and underground coal mining combined with the use of bases to combat acid pollution from coal mines. The differences between the $7 and the $11 scenarios are mainly due to greater increases in underground coal mining in the $11 scenarios.

Total Dissolved Solids -- Total dissolved solids decrease from 1972 over 95 percent in each of the 1985 scenarios. These decreases are almost entirely attributable to increased controls on total dissolved solids pollution from surface and underground coal mining.

Suspended Solids -- Suspended solids decrease from 1972 over 95 percent in each of the 1985 scenarios. These decreases are almost entirely attributable to increased controls on suspended solids pollution from surface and underground coal mining.

Air Pollutants:

Sulfur Oxide -- Sulfur oxide loadings account for over 26 percent of the total national sulfur oxide pollution in each 1985 scenario.

Carbon Monoxide -- Carbon monoxide levels decrease over 80 percent from 1972 in all four 1985 scenarios. These decreases are largely due to reductions in refinery production, and increased carbon monoxide controls on refineries.

Land Use:

Solids -- Solid waste generation decreases from 1972 about 60 percent in the $7 scenarios, and about 40 percent in the $11 scenarios. These decreases are almost entirely due to increased solid waste controls on surface coal mining. Partially affecting

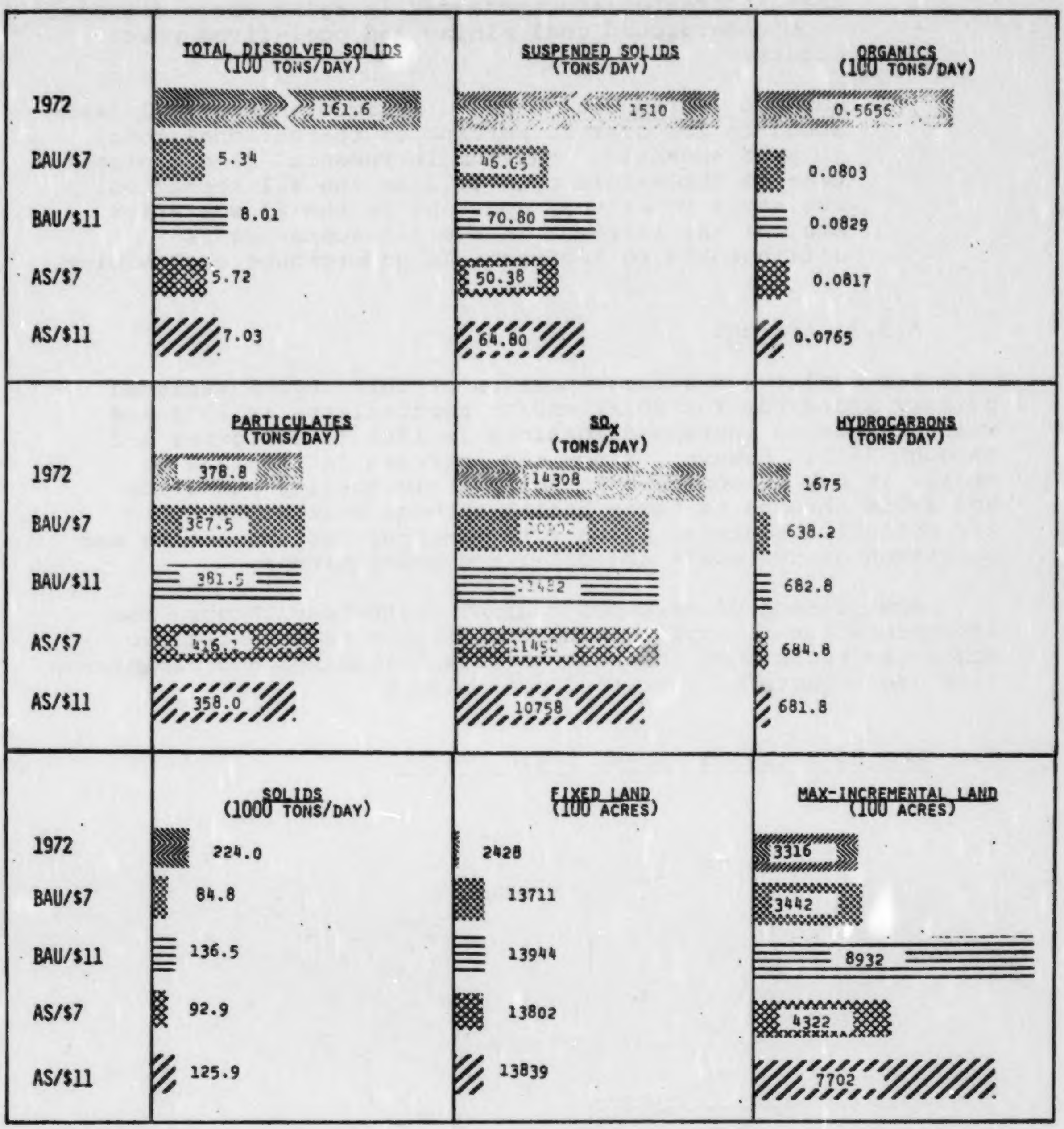


FIGURE A-4

REGIONAL POLLUTION LOADINGS
EAST NORTH CENTRAL

these decreases are increases in solid waste disposal from underground coal mining and coal-fired power plants.

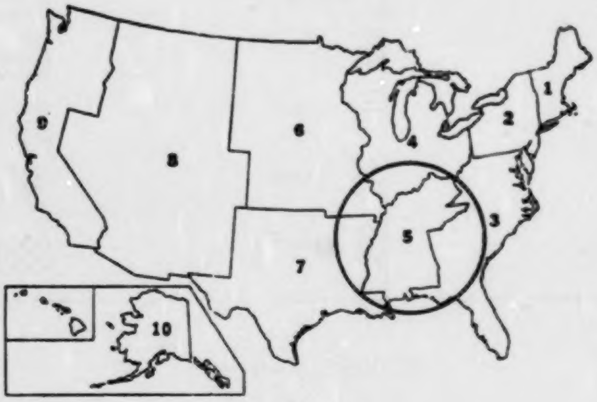
Maximum Incremental Land -- Maximum incremental land accounts for over 20 percent of the national total in each scenario. Maximum incremental land increases two- to three-fold over 1972 in the $11 scenarios, but stays relatively constant in the $7 scenarios. Most of the increase in the $11 scenarios is attributable to increases in underground coal mining.

A.5.3 Addenda

Air quality in a large portion of this region violated primary standards for SO(X) and/or particulates in 1972 and will experience increased loadings in 1985 (see Figures 3-2 through 3-5). However, since the increase in loadings is small, it may be possible to achieve air quality standards and avoid threats to human health through control of other air pollution sources, along with planning for the siting and operation of new coal- and oil-fired power plants.

Application of advanced control technology through the implementation of surface mine reclamation is essential to achieving reductions in water pollutant loadings and minimizing land use impacts of increased coal mining.

A.6 Demand Region 5 - East South Central



DEMAND REGIONS

TABLE A-5

DEMAND REGION 5

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	202.76	292.419	292.419	292.419	292.419	(E3 TONS/DAY)
UNDERGROUND COAL	216.707	18.8844	109.323	27.7797	65.3469	(E3 TONS/DAY)
NATURAL GAS	471.271	269.941	273.223	292.116	292.116	(E6 SCF/DAY)
OIL	212.277	16.2037	26.6175	16.0922	16.0922	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	0	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS						
COAL-FIRED	181.143	216.865	311.673	217.435	233.86	(E3 TONS/DAY)
OIL-FIRED	3.24252	36.5076	21.5539	38.5847	26.06	(E3 BBLS/DAY)
GAS-FIRED	382.449	248.915	188.309	245.7	230.091	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	0	9.19881E-2	9.19881E-2	0.107798	0.107798	(TONS U-235/DAY)
HYDROELECTRIC	5.3931	19.6635	19.6635	19.6635	19.6635	(E3 MWATTS)
REFINERIES	428.75	314.146	328.265	352.512	441.829	(E3 BBLS/DAY)

A.6.1 Energy Production

This region produces about 15 percent of national surface mined coal under all scenarios.

Coal-fired electricity generation increases by 72 percent under the BAU $11 scenario, but only by about 20 percent under the other scenarios. Nuclear power generation increases from zero in 1972 to about 15 percent of national nuclear power generation in 1985.

A.6.2 Pollution Loadings

Due to application of control technology to coal mining, loadings of acids, TDS and SS significantly under all scenarios. Thermal loadings increase due mostly to nuclear generation.

All air pollutant loadings except particulates and NO(X) decline in all scenarios (aldehydes increase in AS $11). Fixed land use increases due to increased hydroelectric capacity.

Water Pollutants:

Bases and suspended solids account for approximately 20 percent of their respective national totals in each scenario.

Suspended Solids -- Suspended solids decrease from 1972 over 95 percent for all four 1985 scenarios. The majority of these changes are accounted for by corresponding increases in controls on suspended solids pollution from surface coal mining. The $11 scenarios show smaller decreases in total suspended solids as a result of smaller decreases in underground coal mining.

Thermal -- Thermal pollution increases 50 percent over 1972 for all four 1985 scenarios. This is chiefly due to increases in nuclear power generation in each scenario.

Air Pollutants:

Carbon Monoxide -- Carbon monoxide loadings decrease 50 to 65 percent from 1972 for all four 1985 scenarios. In each case the reduction is almost entirely accounted for by increased controls on carbon monoxide pollution from refineries or reduced refinery production. Increased production from coal-fired power plants accounts for the larger total carbon monoxide pollution in the Business-as-Usual $11 scenario than in the other scenarios.

Land Use:

Fixed Land -- In all four 1985 scenarios the amount of fixed land is 3.5 times the 1972 amount. These rises are almost entirely attributable to hydroelectric power capacity increases in each scenario. Coal-fired power plants in the Business-as-Usual $11 scenario account for the higher total of fixed land for that scenario.

Maximum Incremental land -- In each scenario maximum incremental land accounts for approximately 20 percent or more of the national total.

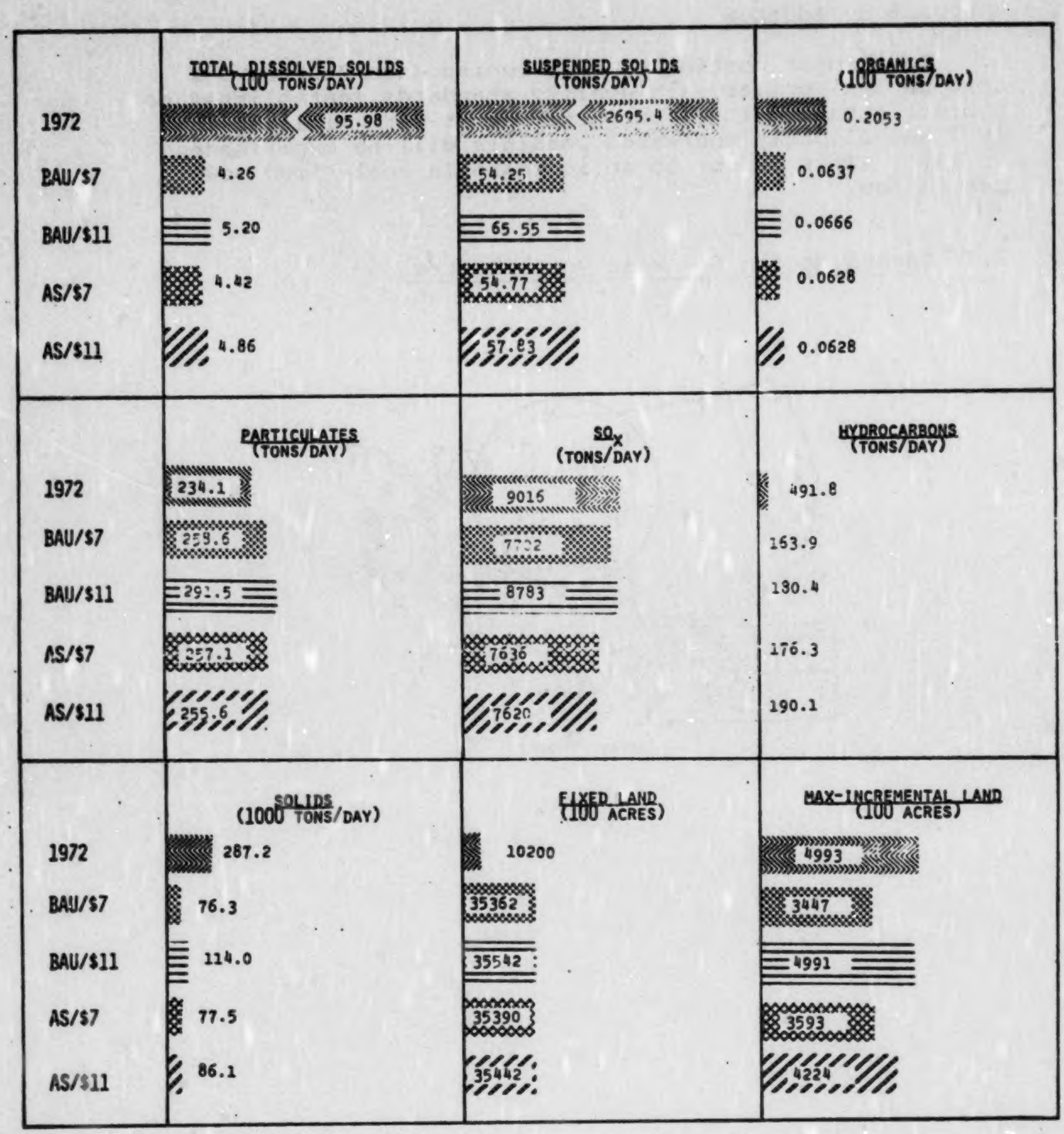


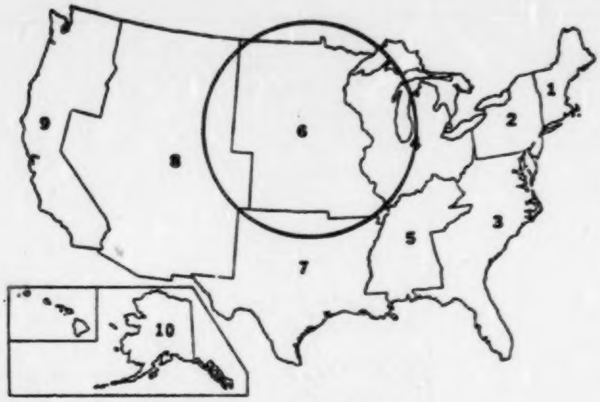
FIGURE A-5

REGIONAL POLLUTION LOADINGS
EAST SOUTH CENTRAL

A.6.3 Addenda

In a major portion of this region (see Figures 3-2 through 3-5) primary air quality standards (established to protect human health) for particulates were violated in 1972 and slightly increased loadings will be experienced in 1985. This is due to an increase in coal-fired power generation.

A.7 Demand Region 6 - West North Central



DEMAND REGIONS

TABLE A-6

DEMAND REGION 6

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	35.3652	78.2735	78.032	80.6506	80.6266	(E3 TONS/DAY)
UNDERGROUND COAL	0.96448	21.1737	102.265	34.3945	85.169	(E3 TONS/DAY)
NATURAL GAS	2588.55	2477.3	2477.3	2618.74	2618.74	(E6 SCF/DAY)
OIL	280.255	202.874	327.03	202.874	202.874	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	98.832	98.832	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	0	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS						
COAL-FIRED	66.6842	124.441	134.25	126.786	119.674	(E3 TONS/DAY)
OIL-FIRED	5.58286	44.1551	33.5464	44.9025	34.9639	(E3 BBLS/DAY)
GAS-FIRED	888.655	382.745	311.592	379.036	360.515	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	1.69558E-3	2.39307E-2	2.39307E-2	2.79191E-2	2.79191E-2	(TONS U-235/DAY)
HYDROELECTRIC	8.51174	13.6097	13.6097	13.6097	13.6097	(E3 MWATTS)
REFINERIES	827.101	827.09	877.741	788.936	873.664	(E3 BBLS/DAY)

A.7.1 Energy Production

Coal mining increases under all scenarios, especially the $11 scenarios. Coal-fired power generation nearly doubles in all scenarios.

A.7.2 Pollution Loadings

Thermal, SO(X), NO(X) and particulate loadings increase under all scenarios due to increased coal-fired power generation.

Maximum incremental land use increases from a relatively small amount in 1972, due mostly to subsidence from underground coal mining.

High Btu coal gasification occurs in the AS scenarios as a new energy production development, accounting for insignificant pollution loadings.

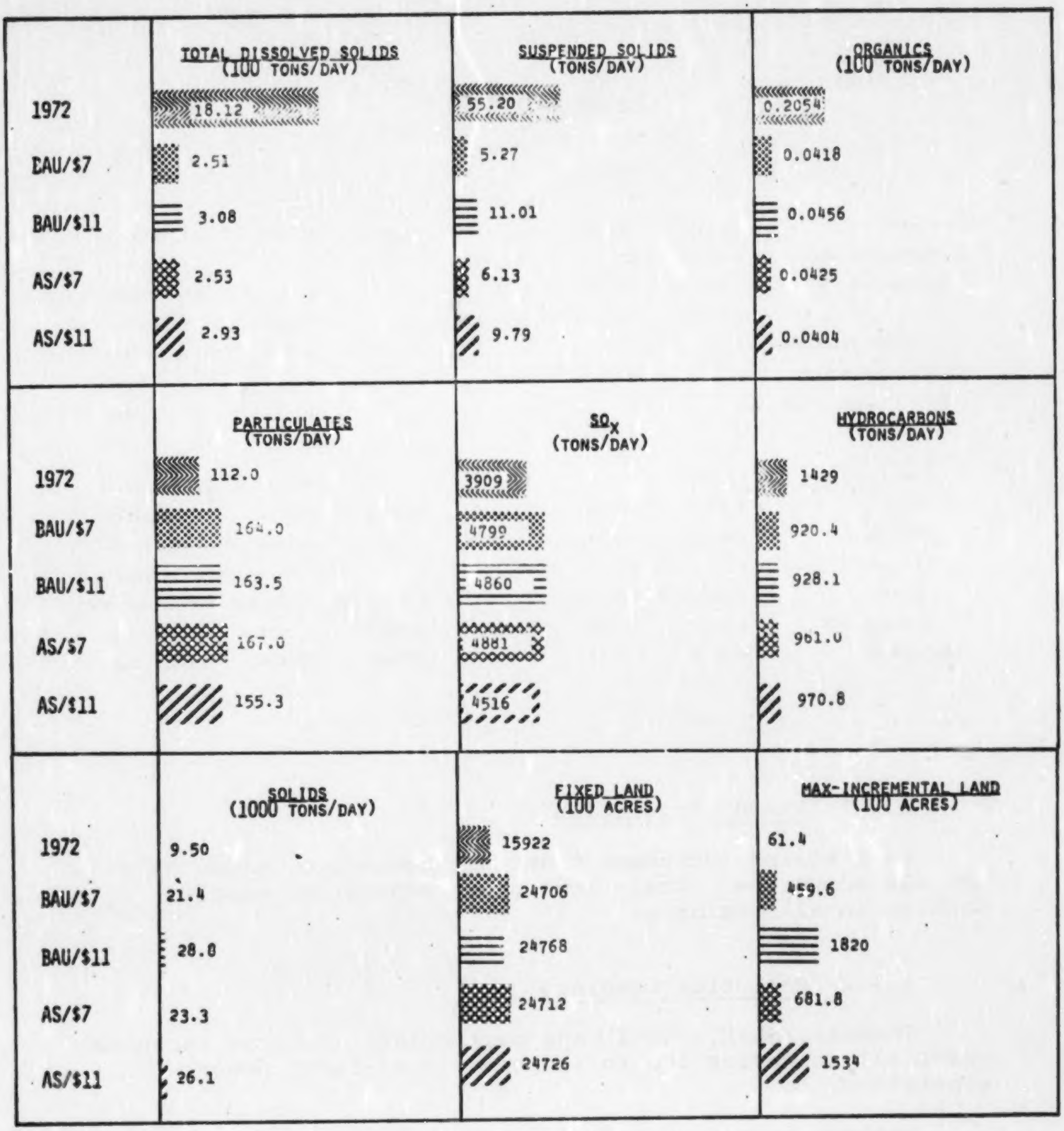


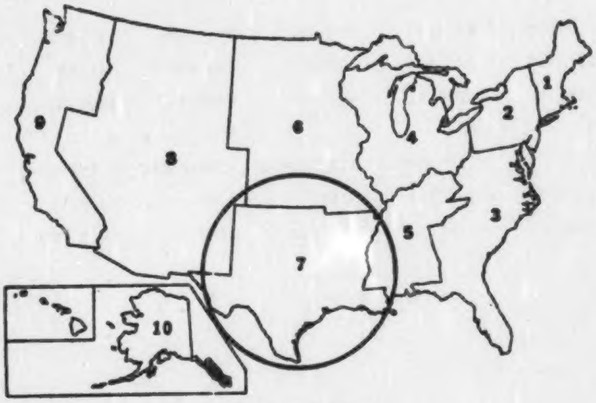
FIGURE A-6

REGIONAL POLLUTION LOADINGS
WEST NORTH CENTRAL

A.7.3 Addenda

Ambient air quality in a portion of this region violated primary air quality standards (established to protect human health) for SO(X) and/or particulates in 1972, and will experience increased loadings in 1985, primarily due to increases in coal-fired power generation (see Figures 3-2 to 3-5).

A.8 Demand Region 7 - West South Central



DEMAND REGIONS

TABLE A-7

DEMAND REGION 7

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	19.243	80.4289	426.54	80.4489	293.935	(E3 TONS/DAY)
UNDERGROUND COAL	5.21148	4.42776	9.88488	5.26839	8.49683	(E3 TONS/DAY)
NATURAL GAS	58820.8	39734.5	39734.5	43203	43203	(E6 SCF/DAY)
OIL	6428.22	4256.29	6203.88	4471.96	5707.52	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	0	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS						
COAL-FIRED	3.21865	58.6557	273.682	58.6557	191.442	(E3 TONS/DAY)
OIL-FIRED	2.13528	221.894	132.637	225.495	146.535	(E3 BBLS/DAY)
GAS-FIRED	4962.12	5798.13	4153.29	5728.73	4939.03	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	0	3.29489E-2	3.29489E-2	3.84403E-2	3.84403E-2	(TONS U-235/DAY)
HYDROELECTRIC	1.18072	3.69811	3.69811	3.69811	3.69811	(E3 MWATTS)
REFINERIES	5541.5	4384.9	4407.22	4849	6063.22	(E3 BBLS/DAY)

A.8.1 Energy Production

Surface coal production increases under all scenarios. However, the increases under the $11 scenarios are much larger than under the $7 scenarios.

Total oil and natural gas production decreases even though OCS oil and natural gas production increases.

Coal-fired and oil-fired power generation increase under all scenarios. Natural gas-fired power generation increases under the $7 scenarios.

A.8.2 Pollution Loadings

Under all scenarios some of the additional loadings from increased thermal electric generation and coal mining are offset by decreased loadings from oil and natural gas production and oil refining. The decreases reflect a decline in production in most scenarios, plus application of control technology. This indicates a possible large shift in the location of the source of loadings by 1985. In addition, the type of loadings changes. For example, while CO and HC loadings increase due to oil- and coal-fired power generation increases.

Water Pollutants:

Total Dissolved Solids -- Total dissolved solids decrease from 1972 approximately 50 percent or more for all four 1985 scenarios. These decreases are due primarily to increases in controls on surface coal mining and refineries. Increased refining throughput the Accelerated Supply $11 scenario accounts for higher totals in that scenario.

Organics -- Organic loadings account for over 30 percent of the national total in each scenario. Organics pollution decreases from 1972 over 50 percent in all four 1985 scenarios. The changes are due almost entirely to increased controls on organics pollution from refineries.

Air Pollutants:

Nitrogen Oxide -- Nitrogen oxide loadings increase 50 percent over 1972 in the $7 scenarios, and 100 percent over 1972 in the $11 scenarios. These increases are due mainly to increases in electricity generation from coal-fired power plants.

Hydrocarbons -- In each scenario, hydrocarbon emissions account for 70 percent of the national total. Hydrocarbons, however, decrease over 40 percent from 1972 in the Business-as-Usual scenarios, and over 30 percent in the Accelerated Supply scenarios. These decreases are almost entirely attributable to decreases in natural gas production and to increases in controls on hydrocarbon emissions from refineries.

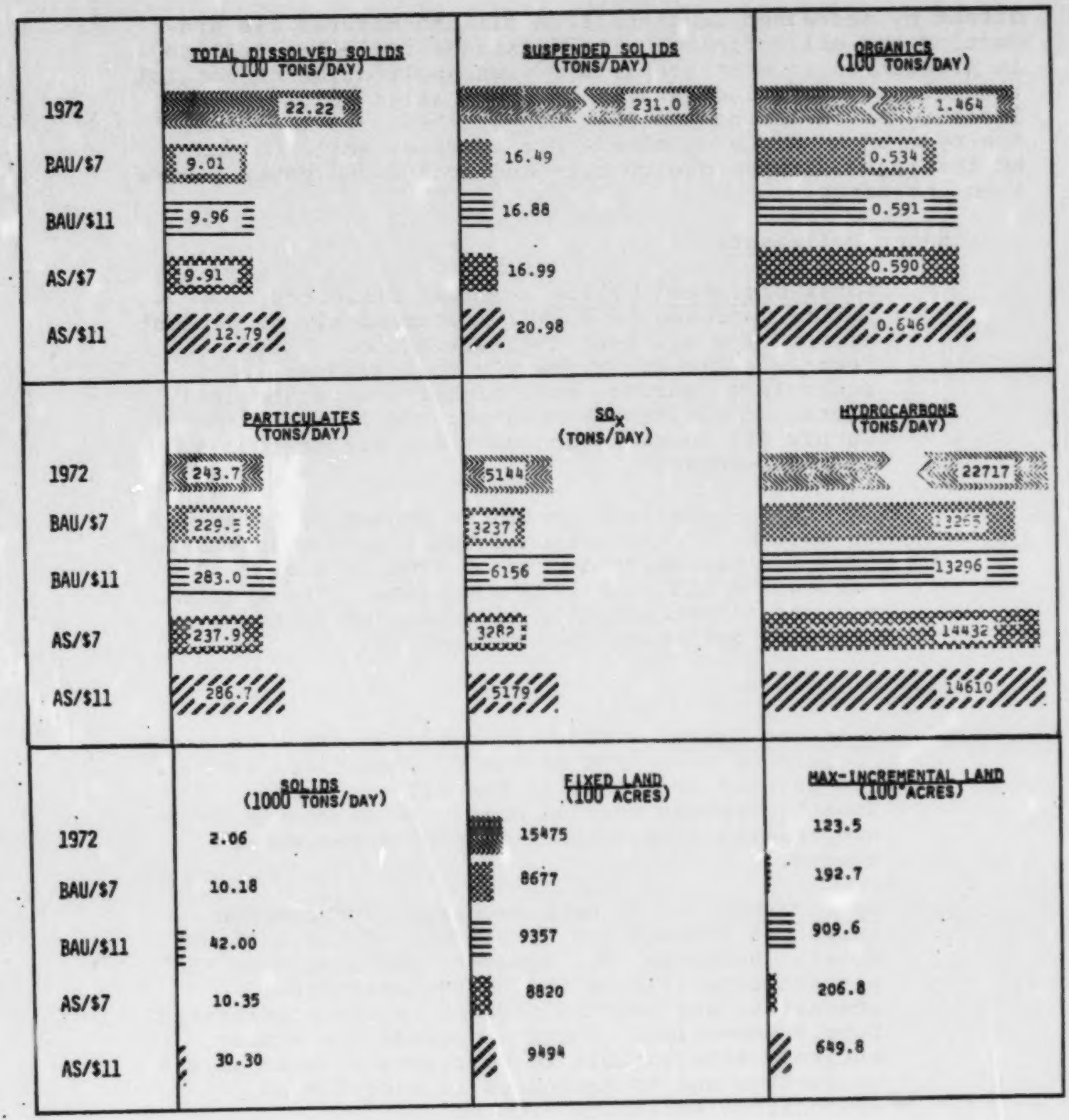


FIGURE A-7

REGIONAL POLLUTION LOADINGS
WEST SOUTH CENTRAL

Carbon Monoxide -- Carbon monoxide loadings decrease from 1972 over 90 percent in all four scenarios. These decreases are almost entirely accounted for by increased controls on carbon monoxide emissions from refineries.

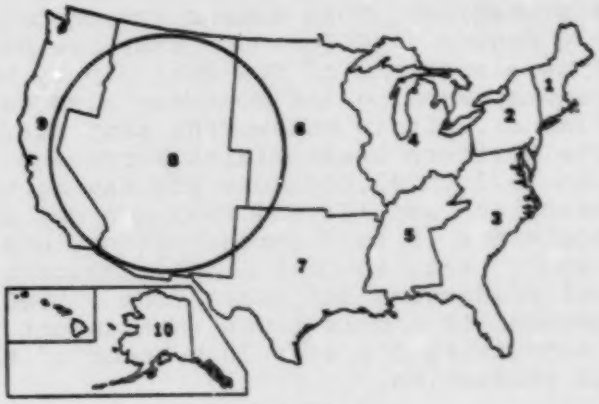
Aldehydes -- In each scenarios aldehyde loadings account for over 20 percent of the national totals.

A.8.3 Addenda

In a major portion of this region ambient concentrations of SO(X) and/or particulates violated primary air quality standards in 1972 in areas that will experience additional loadings in 1985 (see Figures 3-2 to 3-5). Additional analysis is necessary to determine if ambient air quality standards are threatened in areas where standards were not violated in 1972 but where large increases in loadings are predicted to occur.

The possible significant shift of both the source and type of pollution loadings in this region could create a conflict with other land uses such as urban development, agriculture, recreation, and wildlife habitat. This shift could also pose a threat to the preservation of a number of rare and endangered wildlife species, including the Whooping Crane, which inhabit areas of potential energy development.

A.9 Demand Region 8 - Mountain



DEMAND REGIONS

TABLE A-8

DEMAND REGION 8

PRODUCTION

	1972	DAU-$7	DAU-$11	AS-$7	AS-$11	
SURFACE COAL	85.0688	419.919	564.263	431.423	543.512	(E3 TONS/DAY)
UNDERGROUND COAL	22.7656	59.0478	64.3772	51.0478	59.0478	(E3 TONS/DAY)
NATURAL GAS	7810.37	4083.56	4083.56	4359.37	4359.37	(E6 SCF/DAY)
OIL	914.877	514.456	1067.29	514.456	578.704	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	225.968	225.968	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	55	56	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	250	250	1000	1000	(E3 BBLS/DAY)
POWER PLANTS						
COAL-FIRED	58.4968	231.321	334.233	254.877	299.524	(E3 TONS/DAY)
OIL-FIRED	3.77746	25.0577	26.5767	43.5019	27.7373	(E3 BBLS/DAY)
GAS-FIRED	597.956	161.634	52.1029	160.997	117.213	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	0	1.70154E-2	1.70154E-2	1.98513E-2	1.98513E-2	(TONS U-235/DAY)
HYDROELECTRIC	16.1268	29.3082	29.3082	29.3082	29.3082	(E3 MWATTS)
REFINERIES	812.747	607.949	787.088	731.016	443.84	(E3 BBLS/DAY)

A.9.1 Energy Production

Surface coal production in this region increases significantly in all scenarios. This demand region contains all of FEA coal Supply Region 6 (Colorado, Utah, New Mexico and Arizona) as well as almost all of FEA Coal Supply Region 5 (North and South Dakota, Wyoming and Montana; also called the Northern Great Plains). It is noteworthy that surface coal production in the Northern Great Plains increases from 68,000 tons per day in 1972 to 93,000 tons per day in the Business-as-Usual scenarios, and 114,000 tons per day in the Accelerated Supply scenarios (5 to 7 percent of national surface coal production). Yet, in Coal Supply Region 6 (Rocky Mountains) coal production increases from 35,000 tons per day in 1972 to between 10 and 14 times that amount in the 1985 scenarios, accounting for over 20 percent of the national surface coal production.

Oil shale development occurs entirely in this demand region. Consequently, significant portions of the total solid waste, maximum incremental land and particulates loadings for Demand Region 8 are attributable to the development of oil shale. In all four 1985 scenarios oil shale production contributes to a lesser degree to all six air pollutants and fixed land.

A.9.2 Pollution Loadings

Air Pollutants:

Particulates -- Particulates increase two-fold over 1972 in the Business-as-Usual scenarios, and five-fold in the Accelerated Supply scenarios. These increases, even with application of advanced control technology, are due mainly to oil shale development and increases in surface coal mining and coal-fired power plant production. Higher totals for particulates in the Accelerated Supply scenarios reflect higher levels of oil shale development in those scenarios.

Carbon Monoxide - Carbon monoxide levels decrease 50 to 65 percent from 1972 in all four scenarios. These decreases are largely accounted for by increased emission controls on carbon monoxide from refineries. This increase in control is somewhat offset by an increase in coal-fired power generation. The higher levels of coal-fired power generation in the $11 scenarios account for the higher totals of carbon monoxide in those scenarios.

Land Use:

Solids -- Solid waste generation accounts for about 50 percent of the national total in the Business-as-Usual scenarios, and about 80 percent of the national total in the Accelerated Supply scenarios. Solid wastes were insignificant in 1972. The majority of the increases are attributable to oil shale development.

Fixed Land -- Fixed land increases by about three-fourths over 1972 for all four 1985 scenarios. This increase is due almost entirely to an increased hydroelectric power generation in each scenario.

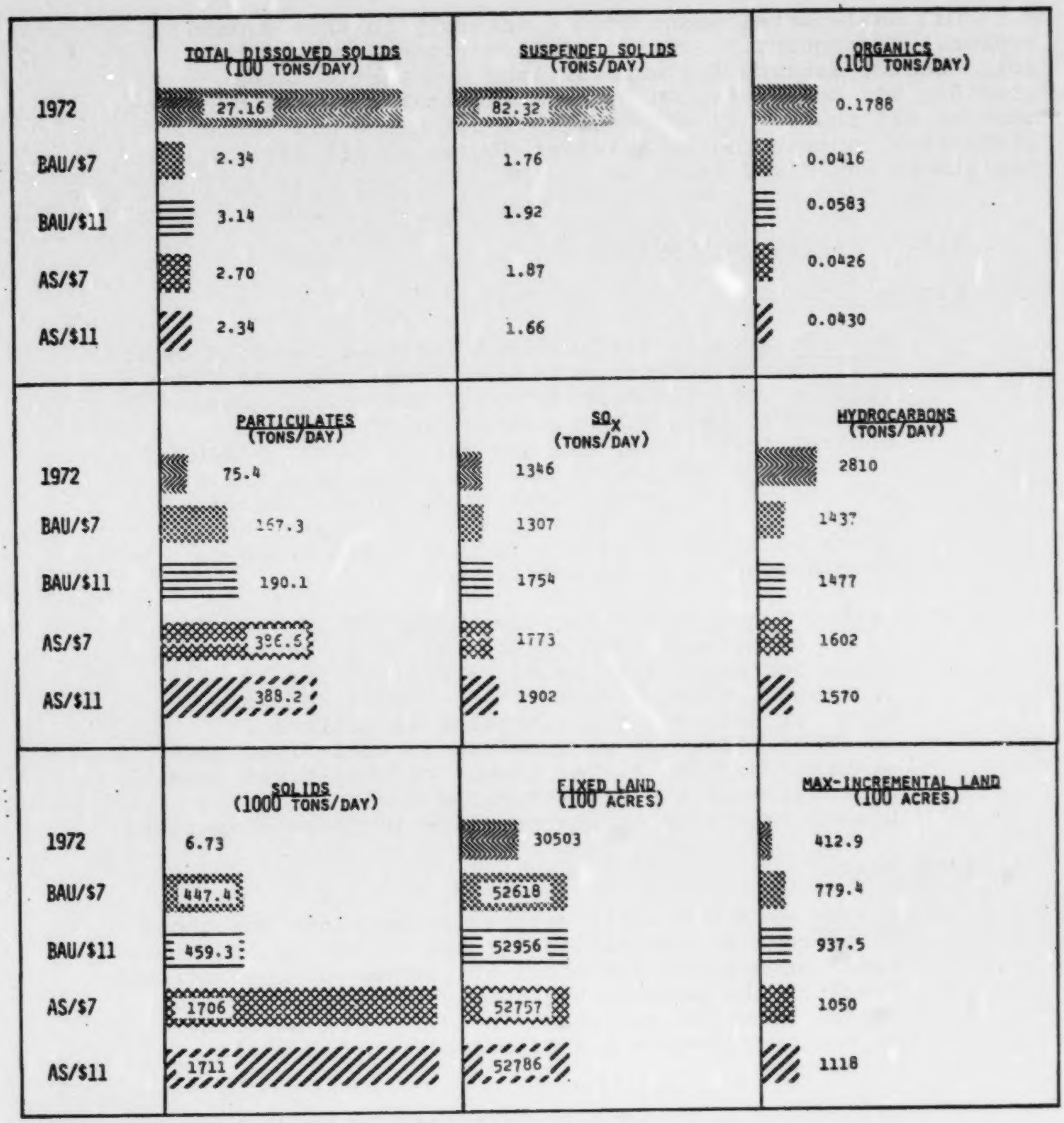


FIGURE A-8

REGIONAL POLLUTION LOADINGS

MOUNTAIN

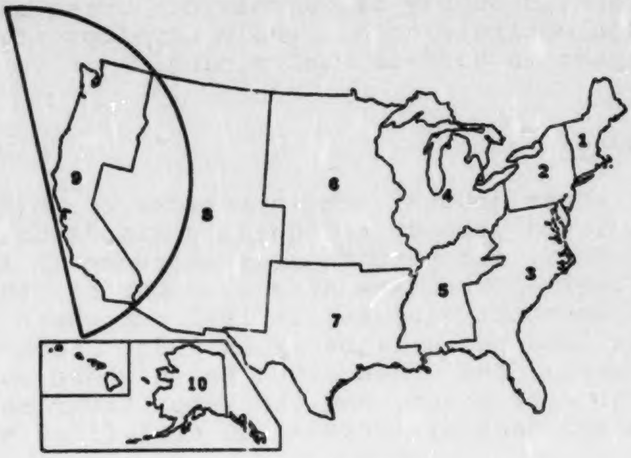
Maximum Incremental Land -- Maximum incremental land increases 90 percent over 1972 in the Business-as-Usual $7 scenario, 127 percent in the Business-as-Usual $11 scenario, 150 percent in the Accelerated Supply $11 scenario. These increases are due entirely to oil shale development and to increases in surface coal mining.

A.9.3 Addenda

In several areas ambient concentrations of SO(X) and particulates violated primary air quality standards in 1972, and loadings of SO(X) and particulates increase in 1985 (see Figures 3-2 to 3-5). There are also a number of other areas where standards were not violated in 1972 but where significantly increased loadings will occur in 1985. Such areas include, for example, the Green River Basin where most oil shale development will occur, and the Yampa River Basin where there will be a substantial increase in coal-fired electricity generation.

The pollution loadings from oil shale, most new coal extraction and some coal-fired power plants will occur in areas which at present are relatively undeveloped, and therefore unpolluted. Development of these areas could alter wildlife habitat and reduce recreation values. Some rare and endangered species may be threatened by energy related activities in these undeveloped areas.

A.10 Demand Region 9 - Pacific



DEMAND REGIONS

TABLE A-9

DEMAND REGION 9

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	7.14044	7.14072	7.14072	7.14072	7.14072	(E3 TONS/DAY)
UNDERGROUND COAL	0.07946	0	0	0	0	(E3 TONS/DAY)
NATURAL GAS	1364.38	940.83	940.83	1393.68	1393.68	(E6 SCF/DAY)
OIL	950.112	1012.3	1442.8	1617.1	1617.1	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	0	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS COAL-FIRED	0	14.5143	20.9716	15.9923	18.7938	(E3 TONS/DAY)
OIL-FIRED	91.3094	153.414	162.649	278.471	169.752	(E3 BBLS/DAY)
GAS-FIRED	1925.98	411.009	58.7146	411.009	264.014	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	2.63605E-3	4.89846E-2	4.89846E-2	5.71487E-2	5.71487E-2	(TONS U-235/DAY)
HYDROELECTRIC	35.5934	80.8395	80.8395	80.8395	80.8395	(E3 MWATTS)
REFINERIES	2426.57	2120.71	1860.96	2124.66	2255.55	(E3 BBLS/DAY)

A.10.1 Energy Production

Due to increased development of Pacific OCS, oil production increases in all scenarios; however, natural gas production declines in the Business-as-Usual scenarios. There is an increase in oil-fired power generation, as well as introduction of coal-fired power generation. Gas-fired power generation declines substantially in all scenarios. Hydroelectric capacity is projected at 228 percent of its 1972 level in all scenarios. This would be about 40 percent of the national total.

A.10.2 Pollution Loadings

Application of advanced control technology on refineries causes a substantial reduction in most pollutant loadings.

Organics -- Organics loadings in 1985 are 1 to 20 percent of national loadings depending on the scenario. Loadings decrease from 1972 by two-thirds in the Business-as-Usual scenarios, and by one-third in the Accelerated Supply scenarios. These new loadings of organics are accounted for by tighter controls on refineries, partially offset by increased Pacific OCS oil production. Higher Pacific OCS oil production inthe Accelerated Supply scenarios accounts for the higher total organics pollution for those scenarios.

Hydrocarbons -- Hydrocarbon totals decrease sharply in all 1985 scenarios. Natural gas production accounts for over 50 percent of the total hydrocarbons in the region. The Accelerated Supply scenarios show more hydrocarbon pollution due to higher levels of Pacific OCS natural gas production.

Fixed Land -- In each scenario fixed land accounts for 40 percent of the national total. Fixed land increases by 123 percent over 1972 in all four 1985 scenarios. In each case the increase is due almost entirely to increased hydroelectric power generation.

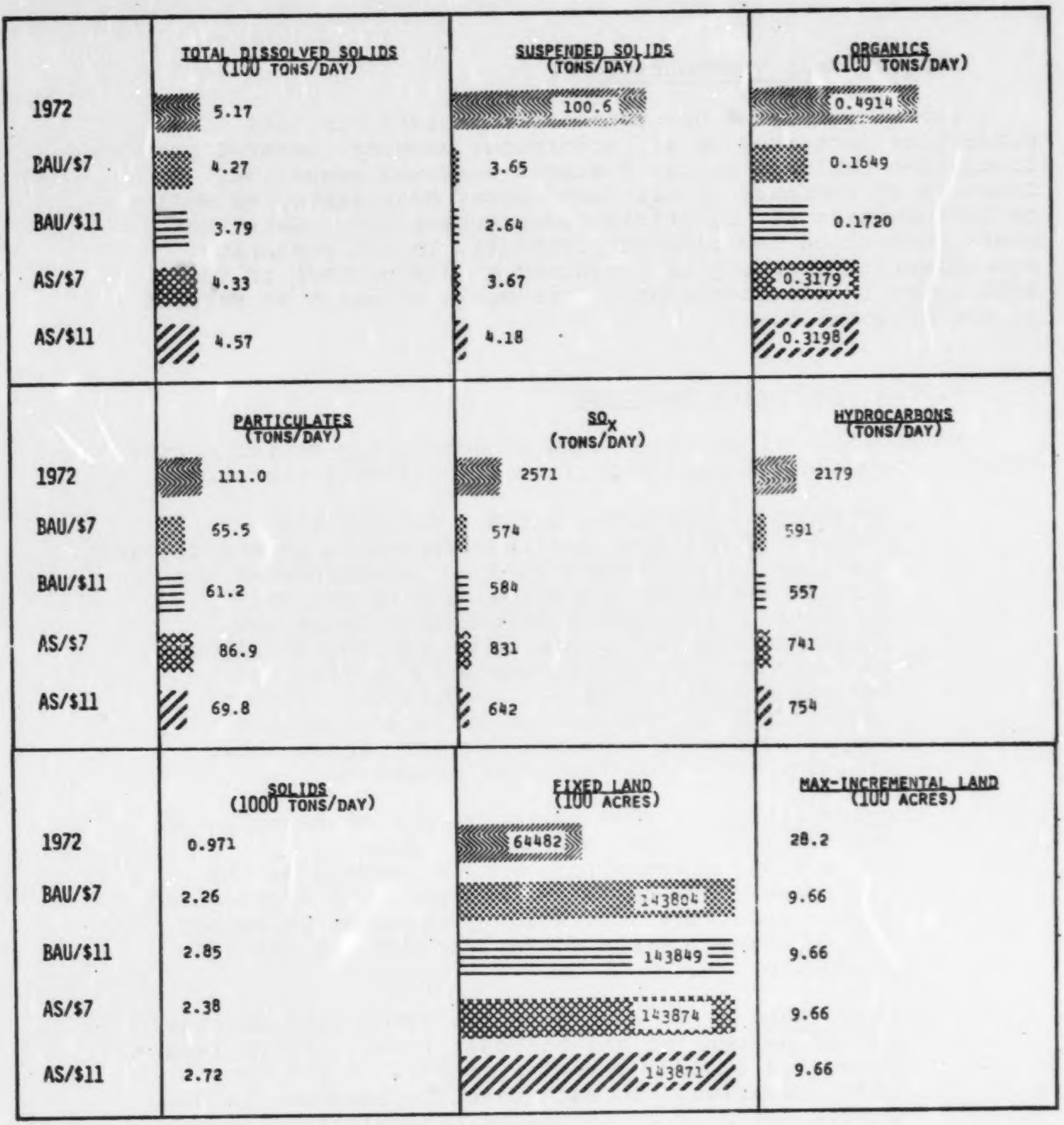


FIGURE A-9

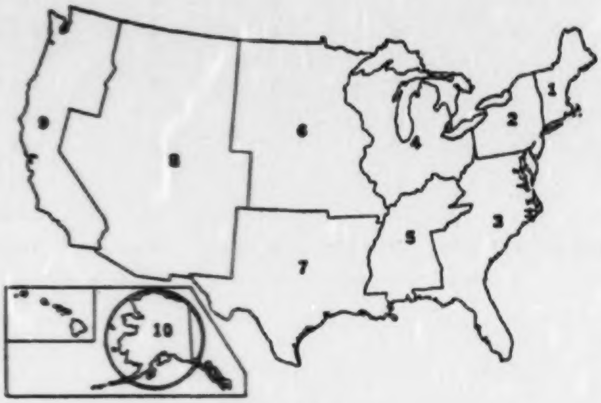
REGIONAL POLLUTION LOADINGS

PACIFIC

A.10.3 Addenda

The greatly increased development of Pacific OCS areas for the production of oil and natural gas, as well as probable increased oil tanker traffic may pose a threat to marine ecology (including rare and endangered species), estuaries, beaches, and commercial and recreational fishing.

A.11 Demand Region 10 - Alaska



DEMAND REGIONS

TABLE A-10

DEMAND REGION 10

PRODUCTION

	1972	BAU-$7	BAU-$11	AS-$7	AS-$11	
SURFACE COAL	1.83032	1.83004	1.83004	1.83004	1.83004	(E3 TONS/DAY)
UNDERGROUND COAL	0	0	0	0	0	(E3 TONS/DAY)
NATURAL GAS	403.666	0	0	0	0	(E6 SCF/DAY)
OIL	199.364	2558.6	2968.2	4558.6	5281.9	(E3 BBLS/DAY)
HI BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
COAL LIQUEFACTION	0	0	0	0	0	(E3 BBLS/DAY)
LO BTU GASIFICATION	0	0	0	0	0	(E6 SCF/DAY)
OIL SHALE	0	0	0	0	0	(E3 BBLS/DAY)
POWER PLANTS COAL-FIRED	0	0	0	0	0	(E3 TONS/DAY)
OIL-FIRED	0.107088	0	0	0	0	(E3 BBLS/DAY)
GAS-FIRED	0	0	0	0	0	(E6 SCF/DAY)
TURBINES	0	0	0	0	0	(E3 BBLS/DAY)
NUCLEAR	0	0	0	0	0	(TONS U-235/DAY)
HYDROELECTRIC	6.14927E-2	0.103477	0.103477	0.103477	0.103477	(E3 MWATTS)
REFINERIES	60	52.8754	46.3991	52.9741	56.2374	(E3 BBLS/DAY)

A.11.1 Energy Production

Under all scenarios there is a significant increase in oil production. The North Slope contributes 2.5 million barrels per day (the capacity of the Trans-Alaskan Pipeline) in the Business-as-Usual scenarios; or 4.5 million barrels per day, including 2 million from Naval Petroleum Reserve 4, in the Accelerated Supply scenarios. Although the FEA model does not differentiate between on- and off-shore production in Alaska, apparently the Alaska OCS is developed under all scenarios. Oil production from areas outside the North Slope is 8 times as great in the Business-as-Usual $11 scenario as 13 times as great in the Accelerated Supply $11 scenario as in the respective $7 scenarios. The FEA model predicts no natural gas production in Alaska under any scenario.

	TOTAL DISSOLVED SOLIDS (100 TONS/DAY)	SUSPENDED SOLIDS (TONS/DAY)	ORGANICS (100 TONS/DAY)
1972	0.144	▨ 2.70	▨ 0.0169
BAU/$7	0.106	0.102	▨ 0.0885
BAU/$11	0.094	0.076	▨ 0.1913
AS/$7	0.106	0.102	▨ 0.1475
AS/$11	0.112	0.115	▨ 0.3305

	PARTICULATES (TONS/DAY)	SO_x (TONS/DAY)	HYDROCARBONS (TONS/DAY)
1972	2.18	54.16	171.7
BAU/$7	0.812	4.94	7.04
BAU/$11	0.713	4.07	6.18
AS/$7	0.813	4.95	7.05
AS/$11	0.863	5.39	7.49

	SOLIDS (1000 TONS/DAY)	FIXED LAND (100 ACRES)	MAX-INCREMENTAL LAND (100 ACRES)
1972	0.154	340.8	6.88
BAU/$7	0.0688	716.1	2.47
BAU/$11	0.0672	724.7	2.47
AS/$7	0.0689	1132.3	2.47
AS/$11	0.697	1150.5	2.47

FIGURE A-10

REGIONAL POLLUTION LOADINGS

ALASKA

A.11.2 Pollution Loadings

Organics -- Organics increase substantially over 1972 in all four 1985 scenarios. These increases are due almost entirely to increases in oil production.

Fixed Land -- Fixed land due to oil production accounts for over 70 percent of the total fixed land in each scenario. Fixed land increases two- to three-fold over 1972 in the Business-as-Usual scenarios, and three- to four-fold over 1972 in the Accelerated Supply scenarios.

A.11.3 Addenda

The development of virgin OCS areas for the production of oil, as well as the oil tanker traffic out of the region implied by the absence of refineries in Demand Region 10, requires consideration of the impacts on marine and estuarine ecosystems, and on commerical fishing. The Alaska OCS, however, deserves special consideration as a particularly fragile virgin area. In fact, the Council on Environmental Quality in April 1974 concluded in a report on virgin OCS oil and natural gas development that:

> "Of the areas studied, the Council concludes that because of its tremendous ecological value as a habitat for many rare, endangered, and important species, the longer physical residence time of oil, and its hostile environment, the Gulf of Alaska appears most vulnerable to major environmental damage from OCS oil and gas development.".

Since the production of oil from the North Slope under the Accelerated Supply scenarios (4.5 million barrels per day) is in excess of the capacity of the pipeline presently under construction (2.5 million barrels per day), an additional pipeline seems necessary.

Although the FEA model predicts no natural gas production from Alaska, it is possible that a natural gas pipeline from the North Slope will be required. Natural gas production from North Slope oil wells exceeds oil well reinjection capacity, and flaring of natural gas is illegal in Alaska.

TABLE B-1

RIVER BASIN INDEX

1. St. John
2. Penobscot
3. St. Croix
4. Machias and Northern Maine coastal
5. Kennebec
6. Androscoggin
7. Presumpscot and Saco
8. Piscataqua
9. Merrimack
10. Connecticut
11. Blackstone
12. Thames
13. Richelieu
14. Housatonic
15. St. Lawrence
16. Hudson
17. Passaic
18. Delaware
19. Susquehanna
20. Genesee, Niagara
21. Delaware, New Jersey coastal (lower Delaware)
22. Maryland coastal (lower Susquehanna)
23. Pocomoke, Nanticoke, Patuxent
24. Potomac, Shenandoah
25. Rappahannock
26. York
27. James
28. Northern Pamlico Bay
29. Chowan
30. Roanoke
31. Tar (Pamlico estuary)
32. Neuse
33. Cape Fear
34. Onslow Bay
35. Pee Dee
36. Santee
37. Rantowless, Cooper
38. Edisto
39. Broad, Coosaw, Coosawatchee, Salkehatchie
40. Savannah
41. Ogeechee
42. Wassaw Sound, Ossabaw Sound
43. Sapelo Sound
44. Altamaha
45. Little Satilla
46. Satilla
47. St. Marys
48. Ferdinand Beach
49. Suwannee
50. Econtina, Fenhollow, Steinhatchee
51. Rocky Creek, Waccasassa
52. St. Johns
53. Withlacoochee
54. Kissimee
55. Hillsborough
56. Southern Florida Drainage
57. Apalachee Bay (St. Marks, Wacissa, Aucilla)
58. Ochlockonee
59. Apalachicola
60. West, North Andrew Bays
61. Choctawatchee
62. Yellow, Blackwater
63. Escambia
64. Alabama

TABLE B-1 (CONT.)

RIVER BASIN INDEX

65.	Tombigbee
66.	Pascagoula
67.	Wolf
68.	Pearl
69.	Lower Mississippi (Natchez to Mouth)
70.	Calcasieu
71.	Little, Dugdemona
72.	Ouachita
73.	South Fork, North Fork, Bayou Fallahala Creek
74.	Big Black
75.	Yazoo
76.	Lower Mississippi (Helena to Natchez)
77.	St. Francis
78.	Ohio
79.	Tennessee
80.	Cumberland
81.	Green
82.	Tennessee (above Hales Bar Dam)
83.	Ohio (Madison to Uniontown)
84.	Wabash
85.	Kentucky
86.	Licking
87.	Big Sandy
88.	Kanawha, New
89.	Scioto
90.	Miami
91.	Kanawa, Hocking
92.	Muskingum
93.	Ohio
94.	Monongahela
95.	Allegheny
96.	Beaver
97.	East Erie Drainage
98.	West Erie Drainage
99.	Maumee
100.	Detroit (Lakes Erie, Huron drainage)
101.	St. Joseph
102.	Kalamazoo, Rabbit, Black
103.	Grand
104.	Saginaw
105.	Muskegan, Manistee
106.	Saginaw Bay
107.	East Great Lakes Drainage
108.	Illinois
109.	Kaskaskia
110.	Meramec
111.	Missouri
112.	Mississippi
113.	Lake Michigan Drainage
114.	Rock
115.	Wapsipinicon
116.	Iowa
117.	Skunk
118.	Des Moines
119.	Lower Mississippi (Fairmont to Louisiana)
120.	Root
121.	Mississippi (St. Paul to Prairie Du Chien)
122.	Wisconsin
123.	Chippewa
124.	Black, Bois Brule, White
125.	St. Croix
126.	Lake Superior and Lake of the Woods Drainage
127.	Upper Mississippi (above St. Paul)
128.	Minnesota

TABLE B-1 (CONT.)

RIVER BASIN INDEX

129. Red River of the North
130. Sweet Water and Devil's Lake
131. Grand
132. Missouri (Nebraska City to Hermann)
133. Kansas
134. Osage
135. Gasconade
136. Blue
137. Lower Republican
138. Clarks Creek
139. Smoky Hill
140. Upper Republican (Ft. Laramie to North Platte)
141. South Platte
142. North Platte
143. Lost Creek, Separation Creek, Black Rock Creek, Fillmore Creek, Bean Creek
144. North Platte (above Ft. Laramie)
145. South Platte (above Sublette)
146. Loop
147. Platte (below North Platte)
148. Elkhorn
149. Missouri (above Blair to Nebraska City)
150. Missouri (Niobrara to above Blair)
151. Big Sioux
152. Blue Dog, Waubay, Pickerel, Lake Parker, Hurricane Lakes
153. James
154. Missouri (above Pierre to Niobrara)
155. White
156. Niobrara
157. Missouri (Mobridge to above Pierre)
158. Cheyenne
159. Moreau
160. Missouri (Williston to Mobridge)
161. Grand
162. Cannonball
163. Hudson Bay Drainage (Souris and Des Lacs Rivers)
164. Little Missouri
165. Heart
166. Missouri (Zortman to Williston)
167. Milk
168. Musselshell
169. Missouri (above Zortman)
170. Lower Yellowstone
171. Tongue
172. Powder
173. Bighorn
174. Upper Yellowstone
175. White
176. Black
177. Arkansas (Van Buren to Little Rock)
178. Arkansas (Tulsa to Van Buren)
179. Neosho
180. Verdigris
181. Middle Canadian
182 Arkansas
183. Lower Cimarron
184. Lower Canadian
185 Arkansas (Lamar to Garden City)
186. Upper Cimarron
187. Upper Canadian
188. Arkansas (above Lamar)
189. Rio Grande (above Espanola)
190. Little
191. Red (Dension to Grand Ecore)
192. Sulphur

TABLE B-1 (CONT.)

RIVER BASIN INDEX

193. Washita
194. Red (above Denison)
195. Trinity
196. Sabine
197. Neches
198. East Galveston Bay
199. Lower Brazos
200. Lower Colorado
201. Lavaca, Matagorda Bay
202. Guadalupe
203. San Antonio
204. Nueceo
205. Brazos (South Bend to Washington)
206. Colorado
207. Upper Colorado
208. Upper Brazos
209. Laguna Madre
210. Rio Grande (below Eagle Pass)
211. Rio Grande (Fort Quitman to Eagle Pass)
212. Lower Pecos
213. Wildhorse Creek
214. Upper Pecos
215. White Sands National Monument
216. Rio Grande (Espanola to Fort Quitman)
217. Upper Gila
218. Whitewater Draw
219. Lower Gila
220. Colorado (below Hoover Dam)
221. Williams, Big Sandy
222. Little Colorado
223. San Juan
224. Colorado (Hall's Crossing to Hoover Dam)
225. Virgin, Muddy, Meadow Valley Wash
226. Dirty Devil
227. Colorado, (above Hall's Crossing)
228. Dolores, San Miguel
229. Gunnison
230. White
231. Strawberry
232. Yampa
233. Blacks Fork
234. Green
235. Sevier
236. Great Salt Lake Basin
237. Truckee, Lake Tahoe, Carson
238. Humbolt, Reese
239. Central Great Basin
240. Owens, Crowley Lake
241. Walker, Mono Lakes
242. Great Basin (Northwestern part in California, Nevada and Oregon)
243. Salton Sea
244. South California costal
245. Santa Ana
246. San Gabriel, Los Angeles
247. Los Angeles Aqueduct, Mojave
248. Santa Clara, Ventura
249. Santa Ynez
250. Santa Marie
251. Central California coastal
252. Salinas
253. Kern Lake
254. San Joaquin
255. Guadalupe, Benito
256. San Pablo, Suisun Bay, Napa

TABLE B-1 (CONT.)

RIVER BASIN INDEX

257. Sacramento
258. Russian
259. Northern California coastal
260. Eel
261. Mad
262. Redwood Creek
263. Klamath
264. Rogue
265. Smith, Chetco
266. Coos, Coquille
267. Umpqua
268. Oregon coastal
269. Willamette
270. Deschutes
271. John Day
272. Umatilla
273. Lower Columbia
274. Olympic Peninsula
275. Puget Sound
276. Yakima, Naches
277. Skagit
278. Northern Puget Sound coastal
279. Chelan
280. Columbia (Grand Coulee to Umatilla)
281. Columbia (International to Grand Coulee)
282. Spokane
283. Palouse
284. Lower Snake
285. Walla Walla
286. Kootenai
287. Pend Orielle
288. Clearwater
289. Salmon
290. Snake (King Hill to Grande Ronde)
291. Malheur
292. Owyhee
293. Boise
294. Snake
295. Salmon
296. Snake (above King Hill)
297. Long Island
298. Hawaii
299. South East Alaska coastal
300. Copper
301. Susitna
302. Kuskokwim
303. Tanana
304. Yukon Upper
305. Porcupine
306. Yukon Middle
307. Koyukuk
308. Yukon Lower
309. Kobuk
310. Noatak
311. Colville
312. Nushagak
313. North Atlantic OCS
314. Central Atlantic OCS
315. South Atlantic OCS
316. East Gulf Coast OCS
317. Central Gulf Coast OCS
318. West Gulf Coast OCS
319. California OCS
320. South Alaska OCS

TABLE B-1 (CONT.)

RIVER BASIN INDEX

321.	West Alaska OCS
322.	North Alaska OCS
4b	Southern Maine coastal
28b	Southern Pamlico Bay
56b	Western Florida coastal
198b	West Galveston Bay
327.	N/A
299b	South Central Alaska coastal
299c	Aleutian Island drainage
299d	South West Alaska coastal
299e	West Alaska coastal
299f	North West Alaska coastal
299g	North Alaska coastal
299h	North East Alaska coastal
107b	West Great Lakes drainage

TABLE B-2

AIR QUALITY CONTROL REGION INDEX

1. Alabama and Tombigbee Rivers (AL)
2. Columbus-Phenix City (AL-GA)
3. East Alabama
4. Metropolitan Birmingham (AL)
5. Mobile-Pensacola-Panama City-S. Miss (AL-FL-MS)
6. Southeast Alabama
7. Tennessee River Valley-Cumberland Mts (AL-TN)
8. Cook Inlet (AK)
9. Northern Alaska
10. South Central Alaska
11. Southeastern Alaska
12. Arizona-New Mexico Southern Border
13. Clark-Mohave (AZ-NV)
14. Four Corners (AZ-CO-NM-UT)
15. Phoenix-Tucson (AZ)
16. Central Arkansas
17. Metropolitan Fort Smith (AR-OK)
18. Metropolitan Memphis (AR-MS-TN)
19. Monroe-El Dorado (AR-LA)
20. Northeast Arkansas
21. Northwest Arkansas
22. Shreveport-Texarkana-Tyler (AR-LA-OK-TX)
23. Great Basin Valley (CA)
24. Metropolitan Los Angeles (CA)
25. North Central Coast (CA)
26. North Coast (CA)
27. Northeast Plateau (CA)
28. Sacramento Valley (CA)
29. San Diego (CA)
30. San Francisco Bay Area (CA)
31. San Joaquin Valley (CA)
32. South Central Coast (CA)
33. Southeast Desert (CA)
34. Comanche (CO)
35. Grand Mesa (CO)
36. Metropolitan Denver (CO)
37. Pawnee (CO)
38. San Isabel (CO)
39. San Luis (CO)
40. Yampa (CO)
41. Eastern Connecticut
42. Hartford-New Haven-Springfield (CT)
43. New Jersey-New York-Connecticut
44. Northwestern Connecticut
45. Metropolitan Philadelphia (DE-NJ-PA)
46. Southern Delaware
47. National Capital (DC-MD-VA)
48. Central Florida
49. Jacksonville-Brunswick (FL-GA)

TABLE B-2 (CONT.)

AIR QUALITY CONTROL REGION INDEX

50. Southeast Florida
51. Southwest Florida
52. West Central Florida
53. Augusta-Aiken (GA-SC)
54. Central Georgia
55. Chattanooga (GA-TN)
56. Metropolitan Atlanta (GA)
57. Northeast Georgia
58. Savannah-Beaufort (GA-SC)
59. Southwest Georgia
60. Hawaii
61. Eastern Idaho
62. Eastern Washington-Northern Idaho
63. Idaho (Remainder)
64. Metropolitan Boise (ID)
65. Burlington-Keokuk (IL-IA)
66. East Central Illinois
67. Metropolitan Chicago (IL-IN)
68. Metropolitan Dubuque (IL-IA-WI)
69. Metropolitan Quad Cities (IL-IA)
70. Metropolitan St. Louis (IL-MO)
71. North Central Illinois
72. Paducah-Cairo (IL-KY)
73. Rockford-Janesville-Beloit (IL-WI)
74. Southeast Illinois
75. West Central Illinois
76. East Central Indiana
77. Evansville-Owensboro-Henderson (IN-KY)
78. Louisville (IN-KY)
79. Metropolitan Cincinnati (IN-KY-OH
80. Metropolitan Indianapolis (IN)
81. Northeast Indiana
82. South Bend-Elkhart-Benton Harbor (IN-MI)
83. Southern Indiana
84. Wabash Valley (IN)
85. Metropolitan Omaha-Council Bluffs (IA-NE)
86. Metropolitan Sioux City (IA-NE-SD)
87. Metropolitan Sioux Falls (IA-SD)
88. Northeast Iowa
89. North Central Iowa
90. Northwest Iowa
91. Southeast Iowa
92. South Central Iowa
93. Southwest Iowa
94. Metropolitan Kansas City (KS-MO)
95. Northeast Kansas
96. North Central Kansas
97. Northwest Kansas
98. Southeast Kansas
99. South Central Kansas

TABLE B-2 (CONT.)

AIR QUALITY CONTROL REGION INDEX

100. Southwest Kansas
101. Appalachian (KY)
102. Bluegrass (KY)
103. Huntington-Ashland-Portsmouth-Ironton (KY-OH-WV)
104. North Central Kentucky
105. South Central Kentucky
106. Southern Louisiana-Southeast Texas
107. Androscoggin Valey (ME-NH)
108. Aroostock (ME)
109. Down East (ME)
110. Metropolitan Portland (ME)
111. Northwest Maine
112. Central Maryland
113. Cumberland-Keyser (MD)
114. Eastern Shore (MD)
115. Metropolitan Baltimore (MD)
116. Southern Maryland
117. Berkshire (MA)
118. Central Massachusetts
119. Metropolitan Boston (MA)
120. Metropolitan Providence (MA-RI)
121. Merrimack Valley-Southern New Hampshire (MA-NH)
122. Central Michigan
123. Metropolitan-Port Huron (MI)
124. Metropolitan Toledo (MI-OH)
125. South Central Michigan
126. Upper Michigan
127. Central Minnesota
128. Southeast Minnesota-La Crosse (MN-WI)
129. Duluth-Superior (MN-WI)
130. Metropolitan Fargo-Moorhead (MN-ND)
131. Minneapolis-St. Paul (MN)
132. Northwest Minnesota
133. Southwest Minnesota
134. Mississippi Delta
135. Northeast Mississippi
136. Northern Piedmont (NC)
137. Northern Missouri
138. Southeast Missouri
139. Southwest Missouri
140. Billings (MT)
141. Great Falls (MT)
142. Helena (MT)
143. Miles City (MT)
144. Missoula (MT)
145. Lincoln-Beatrice-Fairbury (NE)
146. Nebraska (Remainder)
147. Nevada (Remainder)
148. Northwest Nevada
149. Central New Hampshire

TABLE B-2 (CONT.)

AIR QUALITY CONTROL REGION INDEX

150. New Jersey (Remainder)
151. Northeast Pennsylvania-Upper Delaware Valley (PA-NJ)
152. Albuquerque-Mid Rio Grande (NM)
153. El Paso-Las Cruces-Almagordo (NM-TX)
154. Northeast Plains (NM)
155. Pecos-Permian Basin (NM)
156. Southwestern Mountains-Augustine Plains (NM)
157. Upper Rio Grande Valley (NM)
158. Central New York
159. Champlain Valley (NY-VT)
160. Genesee-Finger Lakes (NY)
161. Hudson Valley (NY)
162. Niagara Frontier (NY)
163. Southern Tier East (NY)
164. Southern Tier West (NY)
165. Eastern Mountain (NC)
166. Eastern Piedmont (NC)
167. Metropolitan Charlotte (NC-SC)
168. Northern Coastal Plain (NC)
169. Sandhills (NC)
170. Southern Coastal Plain (NC)
171. Western Mountain (NC)
172. North Dakota (Remainder)
173. Dayton (OH)
174. Greater Metropolitan Cleveland (OH)
175. Mansfield-Marion (OH)
176. Metropolitan Columbus (OH)
177. Northwest Ohio
178. Northwest Pennsylvania-Youngstown (OH-PA)
179. Parkersburg-Marietta (OH-WV)
180. Sandusky (OH)
181. Steubenville-Weirton-Wheeling (OH-WV)
182. Wilmington-Chillicothe-Logan (OH)
183. Zanesville-Cambridge (OH)
184. Central Oklahoma
185. North Central Oklahoma
186. Northeastern Oklahoma
187. Northwestern Oklahoma
188. Southeastern Oklahoma
189. Southwestern Oklahoma
190. Central Oregon
191. Eastern Oregon
192. Northwest Oregon
193. Portland (OR)
194. Southwest Oregon
195. Central Pennsylvania
196. South Central Pennsylvania
197. Southwest Pennsylvania
198. Camden-Sumter (SC)
199. Charleston (SC)

TABLE B-2 (CONT.)

AIR QUALITY CONTROL REGION INDEX

200. Columbia (SC)
201. Florence (SC)
202. Greenville-Spartanburg (SC)
203. Greenwood (SC)
204. Georgetown (SC)
205. Blackhills-Rapid City (SD)
206. South Dakota (Remainder)
207. Eastern Tennessee-Southwestern Virginia
208. Middle Tennessee
209. Western Tennessee
210. Abilene-Wichita Falls (TX)
211. Amarillo-Lubbock (TX)
212. Austin-Waco (TX)
213. Brownsville-Laredo (TX)
214. Corpus Christi-Victoria (TX)
215. Metropolitan Dallas-Fort Worth (TX)
216. Metropolitan Houson-Galveston (TX)
217. Metropolitan San Antonio (TX)
218. Midland-Odessa-San Angelo (TX)
219. Utah (Remainder)
220. Wasatch Front (UT)
221. Vermont (Remainder)
222. Central Virginia
223. Hampton Roads (VA)
224. Northeastern Virginia
225. State Capital (VA)
226. Valley of Virginia
227. Northern Washington
228. Olympic-Northwest Washington
229. Puget Sound (WA)
230. South Central Washington
231. Allegheny (WV)
232. Central West Virginia
233. Eastern Panhandle (WV)
234. Kanawha Valley (WV)
235. North Central West Virginia
236. Southern West Virginia
237. Lake Michigan (WI)
238. North Central Wisconsin
239. Southeastern Wisconsin
240. Southern Wisconsin
241. Casper (WY)
242. Metropolitan Cheyenne (WY)
243. Wyoming (Remainder)

APPENDIX C

PERCENTILE REPRESENTATION OF AIR QUALITY STATISTICS

The frequency distribution of air pollutant concentrations measured over a given time interval generally can be closely approximated by a lognormal curve. That is, if X is a random variable representing the concentration at one location of say, particulates or sulfur oxides, then the distribution of log X is very nearly normal. If n measurements of X are made, and the results are $x_1, \ldots, x_n$, then the geometric mean of the observations is defined as $\sqrt[n]{x_1 x_2 \ldots x_n}$. The logarithm of this statistic is easily seen to be the arithmetic mean of the normally-distributed variable log X, for

$$\log \sqrt[n]{x_1 \ldots x_n} = \frac{1}{n} \sum_{i=1}^{n} \log x_i$$

But for a normal distribution, the arithmetic mean coincides with the median, or 50th percentile. Therefore, the geometric mean of air pollution concentrations whose distribution is nearly lognormal is closely estimated by the 50th percentile.

However, for some pollutants (e.g., sulfur oxides), standard concentration averages are often given in terms of the arithmetic mean. The 50th percentile is not a good approximation to this statistic; in fact, the arithmetic mean of a lognormally distributed variable falls significantly to the right of the median. To compute how far to the right it lies, consider the unit lognormal density function. Its arithmetic mean is

$$\bar{x} = \frac{1}{\sqrt{2\pi}} \int_0^\infty e^{-\frac{1}{2}(\log x)^2} dx = e^{\frac{1}{2}}$$

The probability that the result of a given measurement of X will lie to the left of $\bar{x}$ is therefore

$$P(X<e^{\frac{1}{2}}) = \frac{1}{\sqrt{2\pi}} \int_{0}^{e^{\frac{1}{2}}} \frac{1}{x} e^{-\frac{1}{2}(\log x)^2} dx$$

$$= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{.5} e^{-\frac{1}{2}y^2} dy \approx .69$$

So, the arithmetic mean of lognormally distributed air quality concentrations is very closely represented by the 70th percentile.